Numerical methods - course description

General information

Course name	Numerical methods
Course ID	13.2-WF-FiAP-NM-S17
Faculty	Faculty of Physics and Astronomy
Field of study	Physics
Education profile	academic
Level of studies	First-cycle studies leading to Bachelor's degree
Beginning semester	winter term 2019/2020

Course information

Semester	2
ECTS credits to win	4
Available in specialities	Computer Physics
Course type	obligatory
Teaching language	english
Author of syllabus	

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	30	2	-	-	Exam
Laboratory	30	2	-	-	Credit with grade

Aim of the course

Understanding the basics of Numerical Methods.

Prerequisites

Knowledge of the linear algebra and calculus. Ability to program in C or another programming language at the level sufficient to solve problems.

Scope

Lecture:

The accuracy of the calculations and the types of errors.

Bisection method, secant and Newton's method - approximate root-finding algorithms.

Matrices. Gaussian elimination algorithm, LU decomposition. Inverse matrix. Determinants.

Eigenvalues and eigenvectors, QR method.

Polynomial interpolation, Lagrange's and Newton's method. Spline functions.

Numerical integration, the trapezoidal and Simpson's method. Gaussian quadrature.

Numerical differentiation.

Fast Fourier Transform.

Laboratory:

Searching for roots of the nonanalytical functions by bisection and Newton's method.

Finding the solution of linear equations.

Calculating the integrals using Simpson's method with a given accuracy.

The use of spline functions to the approximate calculation of definite integrals.

Calculations of nodes and weights for Gaussian quadrature.

Teaching methods

Conventional lecture, presentation. Laboratory exercises in the computer lab.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form

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Student is able to compile the program using gcc on Linux (or appropriate for chosen programming language), can find the executable file and other output files generated during the running of the program; can generate a data file in a format suitable for later use gnuplot to visualize the results	• K1A_U04	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student knows gcc compiler (or appropriate for chosen programming language), the basic options and the basic functions of the program gnuplot for graphical presentation of the results of the numerical calculations, can indicate other free software (such as grace) and characterize areas of its applications in physics	• K1A_W09	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student has sufficient knowledge of numerical methods to efficiently use it to solve simple physical problems using the computer, especially knows Gauss elimination method, methods of root-finding (bisection, Newton, secant), QR decomposition, Newton and Lagrange interpolation, spline functions, numerical differentiation, Gaussian quadrature, Fast Fourier Transform	• K1A_W02	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student can write a program to help in the numerical analysis of theoretical results; can write a program that uses numerical procedures to analyse the experimental data, can formulate on this basis relevant proposals	• K1A_U02	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student can find in literature, the description of the numerical method of interest; can in simple programs take advantage of numeric code written by others, uses the instructions to the compiler gcc or appropriate for chosen programming language (eg The GNU C Reference Manual), uses both literature and internet (both in Polish and English as well)	• K1A_U07	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student can choose a suitable numerical method for solving the given physical problem, can read the computer code of programs written by other people and recognizes implemented numerical procedures therein	• K1A_U01	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student has knowledge about the basic algorithms (eg quick sort) to write effective numerical program code in C (or Fortran), knows how to edit, archive and run programs on Linux	• K1A_W04	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory
Student consults with the lecturer in order to solve asked problems, is willing to, in collaboration with other students, to find an optimal method to solve the task	• K1A_K04	• an exam - oral, descriptive, test and other • zaliczenie ćwiczeń programistycznych	• Lecture • Laboratory

Assignment conditions

The condition of positive assessment of the lecture is taking the final test and obtain at least 51% of points.

The pass for the laboratory is to perform all programming exercises.

Before taking the exam a student must obtain a pass from the laboratory.

Final mark: a weighted average rating of the exam (60%) and laboratory (40%).

Recommended reading

[1] Z. Fortuna, B. Macukow, J. Wąsoski, *Metody numeryczne*, WNT, Warszawa 1998.

[2] A. Bjorck, G. Dahlquist, *Metody numeryczne*, PWN, Warszawa 1987.

[3] A. Ralston, *Wstęp do analizy numerycznej*, WNT, Warszawa 1975.

[4] J. i M. Jankowscy, *Przegląd metod i algorytmów numerycznych*, WNT, Warszawa 1981.

[5] W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery, *Numerical Reciepies in C*, CUP,

1992.

Further reading

Notes

Modified by dr hab. Piotr Lubiński, prof. UZ (last modification: 19-02-2020 15:21)