Syllabus for
Numerical Methods in Differential Equations - Spring 2023
Wojciech Mydlarczyk
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This is syllabus for Numerical Methods in Differential Equations. The course provides an introduction to the numerical methods used for approximate solving differential equations.

Topics include:

1. the numerical solution of ordinary differential equations, the analysis of one-step methods, multistep methods, Runge-Kutta (RK) methods, systems of ODEs, stiff problems;

2. the prime integrals for autonomous systems of ordinary differential equations, first and second order partial differential equations.

3. two-point boundary value problems: finite differences for two-point boundary value problems, the Galerkin method,

4. numerical schemes for the first order partial differential equations,

5. the elliptic problems: Poisson equation,

6. the parabolic and hyperbolic initial boundary value problems: the finite difference approximation of the heat equation, space-time finite element methods for the heat equations,

7. hyperbolic equations: the finite difference method for hyperbolic equations, the analysis of finite difference methods, the CFL condition

Special emphasis put on those arising in modelling the problems in science and engineering.

Instructor
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Attendance
The attendance in lectures and laboratory classes is obligatory. Two absences on lectures and laboratory classes are permitted without excusing.

Course Objectives
By the end of the course, you would/should have:

1. learned and used various tools for the numerical solutions of the differential equations.
2. got a feeling and gained insight into the complexity of the numerical methods for differential equations.

Prerequisites
Basic knowledge of calculus, linear algebra and ordinary and partial differential equations is assumed. You will benefit from having familiarity with Matlab(Octave) or Python/Mathematica.

Text
Our main references are handbooks [2] and [6].

Additional recommended texts and readings
You will also find great insight in [1], [3], [4] and [5].

Literature

[1] J. C. Butcher, Numerical Methods for Ordinary Differential Equations, John Wiley & Sons 2003
[2] A. Quarteroni, R. Sacco, F. Saleri, Numerical Mathematics, Springer Berlin Heidelberg 2007
[3] K. W. Morton, D. F. Mayers, Numerical Solution of Partial Differential Equations. An Introduction, Cambridge University Press 2005
[4] Richard L. Burden, J. Douglas Faires, Numerical Analysis
[5] R. M. Mattheij, S. W. Rienstra, J.H.M. ten Thije Boonkkamp, Partial Differential Equations. Modeling, Analysis, Computation
[6] Z. Fortuna, B. Macukow, J. Wąsowicz, Metody Numeryczne, WNT Warszawa 2003

Homeworks

The will be a set of problems approximately every other week on laboratory classes. The students will be assigned homework problems (one or two exercises from each set problem). The main part of the tasks will consist in writing computer codes in Matlab or Python for solving differential problems.

Grading policy

The final grade will be formed on a basis of a sum of points you will for your tasks on laboratory classes. It will can be improved writing a test in examination session.

Room location and hours

Lectures take place at C-5, room 105, on Thursdays, from 9:15 am to 11:00 am.

Office hours:

(see the course website)

Course website

http://mydlarczyk.kft.pwr.edu.pl/

The website contains this syllabus, the problem sets updates and other announcements referred to the course.