Syllabus for
Numerical Methods in Differential Equations - Spring 2025
Wojciech Mydlarczyk
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This is a 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. numerical solution of ordinary differential equations, analysis of one-step methods, multistep methods, Runge-Kutta (RK) methods, systems of ODEs, stiff problems;

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

3. elliptic problems: Poisson equation,

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

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

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

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

Instructor
Wojciech Mydlarczyk, wojciech.mydlarczyk@pwr.edu.pl, Office at Institute of Theoretical Physics, Faculty of Fundamental Problems of Technology, A-1/r. 441

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)/Mathematica.

Text
Our main references are the 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

Homework

There will be a set of problems for laboratory classes and self-studying.

Grading policy
Laboratory: 50%
Final exam: 50%.

Form of the exam: written test.

Dates of the exam: (to be fixed)

Room location and hours
Lectures take place at C-2, room 310, Thursdays, from 9:15 am to 11:00 am.

Office hours:

(will be soon announced)

Course website

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

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