Course requirements

BME Faculty of Natural Sciences
Mathematician BSc/MSc
Applied Numerical Methods with Matlab

Neptun code: BMETE92AM54
BMETE92MM41 **Requirements:** 2/0/2/F/(4/5) (2x45 minutes lecture, 2x45 minutes computer lab, midterm mark, credits to be earned: 4/5 credits)
Semester: spring 2022/23 **Language:** English
Lecturer: Róbert Horváth (A0)
Computer laboratory tutor: Róbert Horváth (A1)

Online materials: MS Teams

Prerequisites: linear algebra, one- and multivariable analysis, ordinary differential equations

Goal of the course: The goal of the course is to introduce, understand and try the basic numerical methods applied in many fields of applied sciences.

Outline of the course:

- Usage of MATLAB (all discussed numerical methods will be introduced and tested in MATLAB)

The discussed topics are:

- error calculation,
- direct and iterative solution of linear systems of equations: Gauss elimination, Gauss transform, factorizations of matrices, condition of linear systems of equations, Jacobi and Gauss-Seidel iterations, relaxation, convergence of the iteration, error estimation,
- estimation of the eigenvalue and the eigenvector, the power method, inverse power method, QR iteration,
- solution of nonlinear systems of equations,
- simple interpolation with polynomials, Hermite interpolation, interpolation with third degree splines, least squares approximations with polynomials and trigonometric polynomials,
- trigonometric interpolation, basics of fast Fourier transform,
- numerical differentiation,
- numerical integration, Newton-Cotes formulas and its usage, Gaussian quadrature,
- numerical solution of initial value problems of ordinary differential equations, basic terms of one-step methods, Runge-Kutta methods, stability, convergence and error estimation of one-step methods, multistep methods,

- numerical solution of boundary value problems of ordinary differential equations.

Attendance requirements. Students are not allowed to miss more than 3 classes. The attendance will be checked regularly.

Midterm tests: Two 90 minutes tests for 36 points each. Hand-written notes, course materials, Matlab codes can be used but it is not allowed to use the help of anyone.

Test 1: 8th week, regularly scheduled lecture on 30 April, Thursday, 12-14, replacement and corrective tests will be organized in the week dedicated to replacements.
Topic: from week 1 to week 7

Test 2: 14th week, regularly scheduled computer lab on 1 June, Thursday, 14-16, replacement and corrective tests will be organized in the week dedicated to replacements
Topic: from week 8 to week 13

Grading rules:

Students will write two tests (so-called recapitulative assessments of knowledge) during the semester. Both tests (90-90 minutes) are worth maximum of 36-36 points and contain both theoretical and computer problems. We call a test successful if the student gain at least 15 points (40%). Besides the tests, the lecturer will appoint some assignments for homework during the semester. The students will have the possibility to collect at least 42 points with these assignments but only maximum of 28 points will count in the final score. Homework assignments are always due to the next class. They cannot be delivered later, and they cannot be corrected or replaced. The minimum requirement from the homework assignments is 12 points (6-6 points from the topics of the weeks 1-6 and 7-13, respectively). Students must have two successful tests and the fulfillment of the minimum requirement from the assignments to obtain a mark at least “pass” (2). Thus, if a student has an unsuccessful test, then he or she must write the test again (replacement test). This will be possible in the week dedicated to replacements (15th week) at a pre-agreed date and time. Both midterm tests can be replaced but only at most once. If one of the replacement tests is unsuccessful then the mark of the student is “fail” (1). It is not allowed to write the test again. With a corrective intent (corrective test), students may write the tests again also parallel with the replacement tests. The results of the new tests (if submitted) replace that of the previous tests. It is not possible to fail with a corrective test. If the corrective test is unsuccessful then the student will get the minimum score 15.

The maximum of the obtainable points in the semester is 100(=36+36+28) points, and the final midterm mark is identified as follows:

42- pass (2)
55- average (3)
70- good (4)
85- excellent (5).

Students who are not familiar with Matlab should go through the introductory Matlab course Matlab Onramp (ca. 2 hours, https://www.mathworks.com/learn/tutorials/matlab-onramp.html).

Consultations: in the office hours of the lecturer (Thursdays 16-17) or in Teams. Here you can ask questions regarding the lectures, computer labs and homework assignments.

Lecture notes:

- Matlab files available in MS Teams.
- Assignments for homework in MS Teams.

Other readings:

- Laurene V. Fausett, Applied Numerical Analysis Using Matlab, Pearson Prentice Hall, 2008
- W. Cheney, D. Kincaid, Numerical Mathematics and Computing, Brooks/Cole, Cangage learning, 2013
- Steven C. Chapra, Applied Numerical Methods with MATLAB - for engineers and scientists, McGraw Hill, 2008

Catch up with Matlab:

- https://www.mathworks.com/moler/chapters.html
- https://web.stanford.edu/class/ee254/software/using_ml.pdf

Budapest, 2nd February 2023

_Horváth Róbert_____
Course leader