Course requirements

BME Faculty of Natural Sciences, physicist MSc
Numerical methods for physicists

Neptun code: BMETE92MF00; **Requirements:** 4/0/2/F/6 (4x45 minutes lecture, 2x45 minutes seminar, midterm mark, credits to be earned: 6 credits);
Semester: autumn 2020/21; **Language:** English;
Lecturer: Róbert Horváth (T0 course);
Computer laboratory tutor: Róbert Horváth (T1, T2)

Website of the course: anal.math.bme.hu/nummeth, MS Teams course

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, optimization type methods for solving linear systems of equations,
  - estimation of the eigenvalue and the eigenvector, the power method, inverse power method, QR iteration,
  - 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,
  - solution of nonlinear systems of equations,
  - 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. Due to the pandemic, there are no attendance requirements. Of course, it is highly recommended to follow the lectures and the computer labs.

Midterm tests: Two 90 minutes tests for 36 points each. You may use your lecture notes, Matlab files, etc., except for the personal assistance of others.

> **Test 1: 8th week, regularly scheduled lecture on 29 October, Thursday, 12:15,** replacement and corrective tests will be organized in the week dedicated to replacements (or in the week 9 if we can find a pre-agreed date). (In the case of offline teaching, this may change.)
> Topic: from week 1 to week 7
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> **Test 2: 14th week, regularly scheduled lecture on 10 December, Thursday, 12:15,** replacement and corrective tests will be organized in the week dedicated to replacements). (In the case of offline teaching, this may change.)
> Topic: from week 8 to week 13

Grading rules:

Students will write two midterm tests (so-called recapitulative assessments of knowledge) during the semester. Both tests (90-90 minutes) are worth maximum of 36-36 points. We call a test successful if the student gain more than 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 week. 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 1-7 and 8-13, 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 obtainable score in the semester is 100(=36+36+28) points, and the final midterm mark is identified as follows:

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

Consultations: In MS Teams in a pre-agreed time.

Lecture notes:

- Slides of the lecture presentation in pdf form, problem sheets, Matlab files and homework assignments all are available in MS Teams

Other readings:

- Steven C. Chapra, Applied Numerical Methods with MATLAB - for engineers and scientists, McGraw Hill, 2008
- W. Cheney, D. Kincaid, Numerical Mathematics and Computing, Brooks/Cole, Cangage learning, 2013

Catch up with Matlab:

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

In Hungarian:

- (the lecture notes to the course in Hungarian) István Faragó, Róbert Horváth, Numerikus módszerek, electronic lecture notes, 2013. (available from the website of the course)
- (the exercise book to the course in Hungarian) István Faragó, Imre Fekete, Róbert Horváth, Numerikus módszerek példatár, electronic lecture notes, 2013. (available from the website of the course)
- G. Stoyan, G. Takó: Numerikus módszerek I-II, Typotex, Budapest, 2002.
- G. Stoyan, Matlab – frissített kiadás: Numerikus módszerek, grafika, statisztika, eszköztárak, Typotex 2011.

Budapest, 23rd August 2020

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Course leader