<!DOCTYPE html PUBLIC „-*W3C*DTD XHTML 1.0 Strict*EN*“ „*http://www.w3.org/TR/2000/REC-xhtml1-20000126/DTD/xhtml1-strict.dtd*“> <html> <title>Numerical mathematics</title> </head><body>   <h1>NUMERICAL MATHEMATICS</h1> Summer semester 2024/2025   <!– Exam terms: <ul> <s></s>Mon 20-th of May, from 9:00 in KN:A-309 Tue 28-th of May, from 9:00 (wait from 8:50 in front of KN:A-214, please) Tue 4-th of June, from 9:00 (wait from 8:50 in front of KN:A-214, please) Tue 11-th of June, from 9:00 (wait from 8:50 in front of KN:A-214, please) Tue 25-th of June, from 9:00 (wait from 8:50 in front of KN:A-214, please)   For enrolment to exam, student must have a valid assessment from tutorials, registered in the electronic system KOS. For terms after 20-th of May, student has to register in the KOS system for the chosen date of the exam.   Caution: The exam will take place at different classroom than the one specified in KOS - wait in front of KN: A-214 from 8:50, please, I will meet you there and tell you the exact place of the exam.   Assessment test term: <ul> <s></s>Mon 13-th of May, from 9:00 in KN:A-309   –> <!– </p–> <!–hr><hr> 2020: Exam test will be available from 15:00 Czech time. Then you will have 5 minutes for reporting any problems with opening the test<!– (be careful to open the appropriate level - mostly B)>. The Lecture meeting in MS Teams will be opened from 14:55 to the end of the test for reporting problems.

 Follow the instructions on the first page of the test, please.
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Lectures: Thursday 12:30-14:00 (room T4:C2-438)
 Tutorials: Friday 12:30-14:00 (room T4:A1-405a) <ul class=„biblio“> <!–li> Detailed information (in Czech) </li–> <hr> <h2>Course Schedule <!– - Lectures –></h2> Week 1 <ul> Introduction. Fixed point iterations: <!–a href=„*http://home.iitk.ac.in/~psraj/mth101/lecture_notes/lecture8.pdf*“>in R</a–> in R with graphical illustration, in R^n - introduction. Vector norms - illustration. Matrices - what are they? Video (I recommend the whole course on linear algebra).
 Graphically: 2×2 matrices as linear transformations Matrix properties. Graphically: Spectral norm and spectral radius. Illustrations in Matlab: <ul> Fixed point iterations Norms and other properties of matrices Matrices as 2D transformations - graphically Matrix norms - graphically   HW Week 2 <ul> fixed point iterations in R^n   Iterative methods for linear systems:
 - graphically: powers of a matrix, Jacobi and Gauss-Seidel iterations
  Solved problems Illustrations in Matlab: <ul> Powers of a matrix - graphically Iterative methods for linear systems   HW Week 3 <ul> Newton's method, example.

* Illustration in Matlab. Video: Newton's method in R and C, Newton's fractal Recapitulation. HW Week 4 <ul> Substitution of derivatives with finite differences.   Cauchy problem for first-order ordinary differential equation:
 explicit and implicit Euler's method, midpoint (Collatz) method. Existence and uniqueness of exact solution: Example. Illustration in Matlab. Video: Euler's method - the basics
 Video: Midpoint method - the basics - first 6:30 minutes
   HW Week 5 <ul> Cauchy problem for systems of ODEs:
 explicit and implicit Euler's method, midpoint (Collatz) method.   Explicit Runge-Kutta methods - example.   One-step methods graphically Illustration in Matlab. Wiki - Runge-Kutta methods.   HW Week 6 <ul> One-step methods - consistence, stability, convergence. <!–a href=„NM/AodrC.pdf“>Order of methods, </a–> Behavior of errors. Stability of Euler's methods: Illustration in Matlab. Video: Gilbert Strang (the first 25 minutes) Video, Gilbert Strang: Lecture I, Lecture II Recapitulation. HW Week 7 <ul> Boundary value problem for ordinary differential equations. Illustration in Matlab. Video: Gilbert Strang, MIT   HW Week 8 <ul> <!–li> Substitution of derivatives with finite differences in 2D. </li–> Classification of the 2-nd order linear partial differential equations of two independent variables. Dirichlet problem for Poisson equation, Finite difference method. Illustration in Matlab. Video: Laplacian HW Week 9 ... 21-st of April: Tutorial cancelled (Easter holiday) Mixed problem for heat equation, Finite difference method. Graphical illustration. Illustration in Matlab. Video: Heat equation <!–li>HW</li–> Week 10 <ul> Mixed problem for wave equation, Finite difference method. Illustration in Matlab.
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 HW from week 9 Week 11 ... 1-st of May: Lecture cancelled (holiday)   HW from week 10 Week 12 ... 8-th of May: Lecture cancelled (holiday)   Recapitulation.   Week 13 <ul> Approximation by polynomials - the least squares method. Illustration in Matlab. Gradient methods. The steepest descent method.
 Illustration in Matlab. Video: Gilbert Strang (the least squares from approx. 25-th minute) HW Recapitulation. <!–a href=„NM/recap.html“>Recapitulation.</a–> <!–li>Examples of test problems (B level). </li–> Week 14 <ul> Assessment test: Thursday 22-nd of May,   12:30 - 14:00, T4:C2-438 <!– Information: <ul> You should be present 10 minutes before the beginning of the test, so that I can give you some short instructions and you are prepared to start writing at 9:00.   No electronic devices are allowed (calculator, notebook, watch, ... etc.). You can use only a sheet of paper which you will be given and your ballpoint pen.   Results will be available on the next Tutorial (Thu 12-th of May at 9:00, room KN:A-447)   Results of the test are here. , 10:45 online

 Exam tests will be available from 10:45 Czech time. Then you will have 5 minutes for reporting any problems with opening the test (be careful to open the appropriate level - mostly B). The Lecture meeting in MS Teams will be opened from 10:40 to the end of the test for reporting problems.

 Follow the instructions on the first page of the test, please.

   Exam test, level A

   Exam test, level B
 Start: 10:50   Czech time
 End: 12:35   (90 + 15 min)

 Any solution sent after 12:35 Czech time will NOT BE ACCEPTED. </li–> <hr> Exams: Requirements for exams. At exam, you should expect similar problems to those given as HWs together with theoretical questions like these, see also requirements above. Examples of exam tests. <hr> <h2>References</h2> <ul class=„biblio“> T. Petersdorff: Fixed Point Iteration and Contraction Mapping Theorem Y. Saad: Iterative methods for sparse linear systems (pdf) J. R. Chasnov: Numerical Methods for Engineers G. Strang: Computational Science and Engineering, selected chapters C. T. Kelley: Iterative Methods for Linear and Nonlinear Equations, SIAM 1995 T. Petersdorff: Errors for Linear Systems M. Zeltkevic:

*Forward and Backward Euler Methods E. Cheever: Fourth Order Runge-Kutta <!–li>D. N. Arnold: Stability, consistency, and convergence of numerical discretizations</li–> I. Berg: Comparison of RK methods Joel Feldman: Variable Step Size Methods   Matlab tutorial - Clarkson University - html * K. B. Petersen, M. S. Pedersen: The Matrix Cookbook - pdf <!–li>http://www.cems.uvm.edu/~tlakoba/math337/ , http://www.mathematik.uni-dortmund.de/~kuzmin/cfdintro/lecture9.pdf http://www.ima.umn.edu/~arnold//8445-8446.14-15/notes.pdf http://www.ann.jussieu.fr/frey/cours/UdC/ma691/ma691_ch6.pdf http://videolectures.net/mit18085f07_computational_science_engineering/ http://www2.imm.dtu.dk/pubdb/views/edoc_download.php/3274/pdf/imm3274.pdf </li–> <h2>Video Lectures</h2> <ul class=„biblio“> Linear transformations and matrices (video) 3Blue1Brown channel: Essence of linear algebra Gilbert Strang: Linear algebra, Unit II: Least Squares, Determinants and Eigenvalues Gilbert Strang: Computational Science and Engineering I, 2008 Gilbert Strang: Computational Science and Engineering II, 2006 3BLUE1BROWN SERIES: Differential equations, studying the unsolvable | DE1 Logistic equation - Video
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