<!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> <li><s></s>Mon 20-th of May, from 9:00 in KN:A-309 </li> <li>Tue 28-th of May, from 9:00 (wait from 8:50 in front of KN:A-214, please) </li> <li>Tue 4-th of June, from 9:00 (wait from 8:50 in front of KN:A-214, please) </li> <li>Tue 11-th of June, from 9:00 (wait from 8:50 in front of KN:A-214, please) </li> <li>Tue 25-th of June, from 9:00 (wait from 8:50 in front of KN:A-214, please) </li> </ul>  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> <li><s></s>Mon 13-th of May, from 9:00 in KN:A-309 </li> </ul> –>  <!– </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. <br><br> Follow the instructions on the first page of the test, please. <br> <hr–> <hr>  <s></s> Lectures:  Thursday  12:30-14:00  (room T4:C2-438) <br> Tutorials:  Friday  12:30-14:00  (room T4:A1-405a)  <ul class=„biblio“> <!–li><a href=„*http://mat.fs.cvut.cz/numer*“> Detailed information </a> (in Czech) </li–> </ul> <hr> <h2>Course Schedule <!– - Lectures –></h2>  Week 1 <ul> <li><a href=„NM/AIntro.pdf“>Introduction</a>.</li> <li>Fixed point iterations:  <!–a href=„*http://home.iitk.ac.in/~psraj/mth101/lecture_notes/lecture8.pdf*“>in R</a–> <a href=„NM/AfixR1.pdf“>in R</a> with graphical illustration,  <a href=„NM/Afix.pdf“>in $R^n$</a> - introduction.</li> <li>Vector norms - <a href=„NM/motiv_metrics.pdf“>illustration.</a></li> <li>Matrices - what are they? <a href=„*https://www.youtube.com/watch?v=kYB8IZa5AuE&list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab&index=3&t=47s&ab_channel=3Blue1Brown*“> Video</a> (I recommend the whole <a href=„*https://www.youtube.com/playlist?list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab*“>course on linear algebra</a>).<br> Graphically: <a href=„NM/domek.pdf“>2×2 matrices as linear transformations</a> </li> <li><a href=„NM/Amatr.pdf“>Matrix properties.</a> Graphically: <a href=„NM/Anorms.pdf“>Spectral norm and spectral radius</a>.</li> <li>Illustrations in Matlab: <ul> <li><a href=„NM/Am_fix.html“>Fixed point iterations</a></li> <li><a href=„NM/Amat1.html“>Norms and other properties of matrices</a></li> <li><a href=„NM/Amat2.html“>Matrices as 2D transformations</a> - graphically</li> <li><a href=„NM/norms.txt“>Matrix norms</a> - graphically</li> </ul> </li> <li> <a href=„NM/Adu1.pdf“>HW</a></li> </ul>  Week 2 <ul> <li> <a href=„NM/Afix.pdf“>fixed point iterations in $R^n$</a> </li> <li> Iterative methods for linear systems:<br> - graphically: <a href=„NM/Apowers.pdf“>powers of a matrix</a>, <a href=„NM/jgs.html“>Jacobi and Gauss-Seidel iterations</a><br> </li> <li><a href=„NM/Alin.pdf“>Solved problems</a></li> <li>Illustrations in Matlab: <ul> <li><a href=„NM/Amat3.html“>Powers of a matrix</a> - graphically</li> <li><a href=„NM/Am_lin.html“>Iterative methods for linear systems</a></li> </ul> </li> <li> <a href=„NM/Adu2.pdf“>HW</a></li> </ul>  Week 3 <ul> <li> <a href=„NM/Anewt.pdf“>Newton's method</a>, <a href=„NM/Anewt_ex1.pdf“>example</a>.

*</li> <li><a href=„NM/Am_newt.html“>Illustration in Matlab.</a></li> <li>Video: <a href=„https://www.youtube.com/watch?v=-RdOwhmqP5s&ab_channel=3Blue1Brown“> Newton's method in R and C, Newton's fractal</a></li> <li>Recapitulation.</li> <li> <a href=„NM/Adu3.pdf“>HW</a></li> </ul>  Week 4 <ul> <li> Substitution of <a href=„NM/Ader.pdf“>derivatives with finite differences</a>. </li> <li> <a href=„NM/AodrR1.pdf“>Cauchy problem for first-order ordinary differential equation:</a> <br> explicit and implicit Euler's method, midpoint (Collatz) method. </li> <li>Existence and uniqueness of exact solution: <a href=„NM/sing_g.pdf“>Example.</a></li> <li><a href=„NM/Am_cauch.html“>Illustration in Matlab.</a></li> <li>Video: <a href=„https://www.youtube.com/watch?v=_0mvWedqW7c“> Euler's method - the basics</a> <br> Video: <a href=„https://www.youtube.com/watch?v=2hjoqAaH5kc“> Midpoint method - the basics</a> - first 6:30 minutes <br> </li> <li> <a href=„NM/Adu4.pdf“>HW</a></li> </ul>  Week 5 <ul> <li> <a href=„NM/AodrS.pdf“>Cauchy problem for systems of ODEs:</a> <br> explicit and implicit Euler's method, midpoint (Collatz) method. </li> <li> Explicit Runge-Kutta methods - <a href=„NM/ARK.pdf“>example</a>. </li> <li> One-step methods <a href=„NM/AodrGr.pdf“>graphically</a></li> <li><a href=„NM/Am_cauch.html“>Illustration in Matlab.</a></li> <li><a href=„https://en.wikipedia.org/wiki/Runge%E2%80%93Kutta_methods“>Wiki - Runge-Kutta methods</a>. </li> <li> <a href=„NM/Adu5.pdf“>HW</a></li> </ul>  Week 6 <ul> <li> <a href=„NM/AodrG.pdf“>One-step methods</a> - consistence, stability, convergence. <!–a href=„NM/AodrC.pdf“>Order of methods, </a–></li> <li><a href=„NM/AodrErrGr.pdf“>Behavior of errors.</a></li> <li>Stability of Euler's methods: <a href=„NM/Am_stab.html“>Illustration in Matlab.</a></li> <li> Video: <a href=„https://ocw.mit.edu/courses/mathematics/18-085-computational-science-and-engineering-i-fall-2008/video-lectures/lecture-10-finite-differences-in-time/“> Gilbert Strang</a> (the first 25 minutes) </li> <li>Video, Gilbert Strang: <a href=„http://www.infocobuild.com/education/audio-video-courses/mathematics/18-086-MathematicalMethods-MITOCW/lecture-01.html“>Lecture I</a>, <a href=„http://www.infocobuild.com/education/audio-video-courses/mathematics/18-086-MathematicalMethods-MITOCW/lecture-02.html“>Lecture II</a> </li> <li>Recapitulation.</li> <li><a href=„NM/Adu6.pdf“>HW</a></li> </ul>  Week 7 <ul> <li><a href=„NM/Aodr2.pdf“>Boundary value problem</a> for ordinary differential equations. </li> <li><a href=„NM/Am_okr.html“>Illustration in Matlab.</a></li> <li> Video: <a href=„https://ocw.mit.edu/courses/mathematics/18-085-computational-science-and-engineering-i-fall-2008/video-lectures/lecture-2-differential-eqns-and-difference-eqns/“> Gilbert Strang, MIT</a> </li> <li> <a href=„NM/Adu7.pdf“>HW</a></li> </ul>  Week 8 <ul> <!–li> Substitution of <a href=„NM/Apder.pdf“>derivatives with finite differences</a> in 2D. </li–> <li><a href=„NM/AClass.pdf“>Classification</a> of the 2-nd order linear partial differential equations of two independent variables.</li> <li>Dirichlet problem for <a href=„NM/APoi.pdf“>Poisson equation</a>, Finite difference method. </li> <li><a href=„NM/Am_poiss.html“>Illustration in Matlab.</a></li> <li>Video: <a href=„https://www.youtube.com/watch?v=EW08rD-GFh0“> Laplacian</a></li> <li><a href=„NM/Adu8.pdf“>HW</a></li> </ul>  Week 9 ... 21-st of April: Tutorial cancelled (Easter holiday) <ul> <li>Mixed problem for <a href=„NM/Aheat.pdf“>heat equation</a>, Finite difference method. </li> <li><a href=„NM/AheatGr.pdf“>Graphical illustration.</a></li> <li><a href=„NM/Am_teplo.html“>Illustration in Matlab.</a></li> <li>Video: <a href=„https://www.youtube.com/watch?v=ly4S0oi3Yz8&t=141s“> Heat equation</a></li> <!–li><a href=„NM/Adu9.pdf“>HW</a></li–> </ul>  Week 10 <ul> <li>Mixed problem for <a href=„NM/Awave.pdf“>wave equation</a>, Finite difference method. </li> <li><a href=„NM/Am_vlna.html“>Illustration in Matlab.</a></li>*

<li> <a href=„NM/Adu9.pdf“>HW</a> from week 9</li> </ul>  Week 11 ... 1-st of May: Lecture cancelled (holiday) <ul> <li> <a href=„NM/Adu10.pdf“>HW</a> from week 10</li> </ul>  Week 12 ... 8-th of May: Lecture cancelled (holiday) <ul> <li> Recapitulation. </li> </ul>  Week 13 <ul> <li> <a href=„NM/Aintap.pdf“>Approximation by polynomials</a> - the least squares method.</li> <li> <a href=„NM/Am_app.html“>Illustration in Matlab.</a></li> <li> Gradient methods. <a href=„NM/Amns.pdf“>The steepest descent method</a>.<br> <a href=„NM/am_grad.html“>Illustration in Matlab</a>. </li> <li>Video: <a href=„https://ocw.mit.edu/courses/mathematics/18-085-computational-science-and-engineering-i-fall-2008/video-lectures/lecture-10-finite-differences-in-time/“> Gilbert Strang</a> (the least squares from approx. 25-th minute) </li> <li><a href=„NM/Adu11.pdf“>HW</a></li> <li> Recapitulation. <!–a href=„NM/recap.html“>Recapitulation.</a–> </li> <!–li><a href=„NM/NM_ang_testex_B.pdf“>Examples of test problems</a> (B level). </li–> </ul>  Week 14 <ul> <li> Assessment test:  Thursday 22-nd of May,   12:30 - 14:00,  T4:C2-438 </li> <!– <li> Information: <ul> <li>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. </li> <li> 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. </li> </ul> </li> <li> Results will be available on the next Tutorial (Thu 12-th of May at 9:00, room KN:A-447) </li> <li> Results of the test are <a href=„NM/vysl.html“>here</a>. </li> , 10:45 online <br><br> <li>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. <br><br> Follow the instructions on the first page of the test, please. <br><br> <ul> <li> <a href=„NM/NM_ang_21_5_13_A.pdf“>Exam test, level A</a><br><br> </li> <li> <a href=„NM/NM_ang_21_5_13_B.pdf“>Exam test, level B</a> </li> </ul> <br> Start:  10:50   Czech time<br> End:   12:35   (90 + 15 min)<br><br> Any solution sent after 12:35 Czech time will NOT BE ACCEPTED. </li–> </ul>  <hr> Exams: <a href=„NM/AA_ex.html“>Requirements</a> for exams. At exam, you should expect similar problems to those given as HWs together with theoretical questions like <a href=„NM/ANM_zk_th.pdf“>these</a>, see also requirements above. <a href=„NM/NM_ang_vzor.pdf“>Examples</a> of exam tests.  <hr> <h2>References</h2> <ul class=„biblio“> <li>T. Petersdorff: <a href=„http://terpconnect.umd.edu/~petersd/666/fixedpoint.pdf“> Fixed Point Iteration and Contraction Mapping Theorem</a> </li> <li>Y. Saad: <a href=„http://www-users.cs.umn.edu/~saad/books.html“>Iterative methods for sparse linear systems </a> ( <a href=„http://www-users.cs.umn.edu/~saad/IterMethBook_2ndEd.pdf“>pdf</a> ) </li> <li>J. R. Chasnov: <a href=„https://www.math.hkust.edu.hk/~machas/numerical-methods-for-engineers.pdf“> Numerical Methods for Engineers</a> </li> <li>G. Strang: Computational Science and Engineering, <a href=„http://ocw.mit.edu/courses/mathematics/18-086-mathematical-methods-for-engineers-ii-spring-2006/readings/“>selected chapters</a></li> <li>C. T. Kelley: <a href=„http://www.siam.org/books/textbooks/fr16_book.pdf“> Iterative Methods for Linear and Nonlinear Equations</a>, SIAM 1995 </li> <li>T. Petersdorff: <a href=„http://terpconnect.umd.edu/~petersd/460/linsysterrn.pdf“> Errors for Linear Systems</a></li> <li>M. Zeltkevic: <a href=„http://web.mit.edu/10.001/Web/Course_Notes/Differential_Equations_Notes/node3.html“>

*Forward and Backward Euler Methods</a> </li> <li>E. Cheever: <a href=„http://lpsa.swarthmore.edu/NumInt/NumIntFourth.html“> Fourth Order Runge-Kutta</a> </li> <!–li>D. N. Arnold: <a href=„http://www.ima.umn.edu/~arnold//papers/stability.pdf“> Stability, consistency, and convergence of numerical discretizations</a></li–> <li>I. Berg: <a href=„https://beltoforion.de/en/runge-kutta_vs_euler/index.php#idStart“> Comparison of RK methods</a> </li> <li>Joel Feldman: <a href=„https://personal.math.ubc.ca/~feldman/math/vble.pdf“>Variable Step Size Methods</a> </li> <li><a href=„http://www.cyclismo.org/tutorial/matlab/“> Matlab tutorial - Clarkson University</a> - html </li> <li>* K. B. Petersen, M. S. Pedersen: <a href=„http://www2.imm.dtu.dk/pubdb/views/edoc_download.php/3274/pdf/imm3274.pdf“> The Matrix Cookbook </a> - pdf </li> <!–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–> </ul> <h2>Video Lectures</h2> <ul class=„biblio“> <li> <a href=„https://www.youtube.com/watch?v=kYB8IZa5AuE&index=4&list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab&t=0s“>Linear transformations and matrices (video)</a></li> <li>3Blue1Brown channel: <a href=„https://goo.gl/R1kBdb“>Essence of linear algebra</a></li> <li>Gilbert Strang: Linear algebra, <a href=„http://ocw.mit.edu/courses/mathematics/18-06sc-linear-algebra-fall-2011/least-squares-determinants-and-eigenvalues/“> Unit II: Least Squares, Determinants and Eigenvalues</a> </li> <li>Gilbert Strang: <a href=„http://ocw.mit.edu/courses/mathematics/18-085-computational-science-and-engineering-i-fall-2008/video-lectures/“> Computational Science and Engineering I, 2008</a> </li> <li>Gilbert Strang: <a href=„http://www.infocobuild.com/education/audio-video-courses/mathematics/18-086-MathematicalMethods-MITOCW/lecture-01.html“> Computational Science and Engineering II, 2006</a> </li> <li>3BLUE1BROWN SERIES: <a href=„https://www.youtube.com/watch?v=p_di4Zn4wz4“> Differential equations, studying the unsolvable | DE1</a> </li> <li>Logistic equation - <a href=„https://www.youtube.com/watch?v=ovJcsL7vyrk&ab_channel=Veritasium“>Video</a><br ></li> </ul> </html> zpět*

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