Numerical Linear Algebra

Course Syllabus

Basic Information

<table>
<thead>
<tr>
<th>Program of study</th>
<th>Applied Computing in Engineering and Science (Master’s Degree)</th>
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</thead>
<tbody>
<tr>
<td>Semester</td>
<td>First (Year 1)</td>
</tr>
<tr>
<td>Course credits</td>
<td>6 ECTS</td>
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<tr>
<td>Language</td>
<td>English level B1 / Intermediate (European Framework of Reference of Communicative Skills)</td>
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<tr>
<td>Prerequisites</td>
<td>B. Sc. degree in Mathematics, Physics or Computer Science</td>
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Course Instructor

Kirillov Kirill Anatol’yevich, D.Sc in Mathematics, Web-pages:


http://www.mathnet.ru/php/person.phtml?&personid=50411&option_lang=eng

Professor in Dept. of Applied Mathematics and Computer Security,

Siberian Federal University, Krasnoyarsk, Russia http://www.sfu-kras.ru

Office: Institute of Space and Information Technology, office 3-11

E-mail: kkirillow@yandex.ru

Required Knowledge

Elementary linear algebra is needed. Elementary level of programming knowledge is required. The knowledge of a high-level programming language such as C++, Fortran would help, but is not required.

Preliminary Reading:


Computing

Access to one of the computing environments such as C++, Fortran, Maple, Matlab, Mathematica, etc. is required in order to do the computer assignments.

Teaching

The course will be taught mainly in lecture format along with class examples and demonstrations. Individual Tasks (Computer Assignments) will be assigned. At the end of the terms the qualification (oral examination) will take place.
Course Description

This course is an introduction to numerical Linear Algebra. Subject of this course are numerical algorithms for solving problems in Linear Algebra, such as linear algebraic systems and corresponding matrix eigenvalue problems.

Course Aims

The aim of this course is to give tools (as classical algorithms) to solve numerically problems in Linear Algebra.

Course Objectives

The course gives classical algorithms to solve linear systems by different methods, and to find the eigenvalues of a matrix. The course details the mathematical theory behind numerical algorithms for solution of linear systems and eigenvalue problems. The emphasis is on iterative methods suitable for large-scale problems arising, e. g., in the discretization of partial differential equations and in network problems.

Special Features

Numerical Linear Algebra is no longer a subtopic of Numerical Analysis, it has grown into an independent topic for research and teaching in recent years. The reason, is, of course, obvious. Numerical Linear Algebra techniques are essential ingredients in scientific computing that are routinely used to solve practical-life problems (Signal Processing, Control Theory, Heat Transfer, Fluid Dynamics, Biomedical Engineering, Vibration, Statistics, Bioscience, Economics).

Outline of Content

1. Introduction to Numerical Linear Algebra, Applications and Origin of Problems.
3. Direct Solution Methods.
4. Iterative Methods for Linear Algebraic Systems.
5. Iterative Methods for Eigenvalue Problems.

Learning Outcomes

After completing the course, the student will be able to

- derive and use the numerical techniques needed for a professional solution of a given linear algebra problem;
- distinguish and analyze a variety of tools that exist for solving linear systems and finding eigenvalues of these systems;
- evaluate when a problem should be solved using a direct or iterative method and what the advantages, disadvantages, and costs are for these methods;
- demonstrate an understanding of the way in which error in data can corrupt solution and, therefore, how much confidence you can place in the solution you obtain.
Projects

The goal of the project is to produce a coherent paper that explains a numerical implementation of some algorithms (Computer Assignments), and gives results. Neatness and notation is important.

Course Assessment

Note: Assessments subject to change. Below there is a tentative version of assessments. The final version will appear prior to start of the course.

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Number</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Computer Assignments</td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>Midterm</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>Final</td>
<td>1</td>
<td>25%</td>
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Attendance Policy

Students are expected to attend classes regularly, since the consistent attendance offers the most effective opportunity open to all students to gain command of the concepts and materials of the course.

References


Academic Honor Policy / Academic Honesty

The Siberian Federal University is built upon a strong foundation of integrity, respect and trust. All members of the university have a responsibility to be honest and the right to expect honesty from others. Any form of academic dishonesty is unacceptable to our community.

Note

The instructor reserves the right to make changes to this syllabus as necessary prior to start of the course.