MATH-453 **Computational linear algebra**

Kressner Daniel

| Cursus | Sem. | Type |
|---|---|---|
| Computational science and Engineering | MA2, MA4 | Opt. |
| Data Science | MA2, MA4 | Opt. |
| Ing.-math | MA2, MA4 | Opt. |
| Mathématicien | MA2 | Opt. |
| Statistics | MA2 | Opt. |

| | |
|---|---|
| Language of teaching | English |
| Credits | 5 |
| Session | Summer |
| Semester | Spring |
| Exam | Oral |
| Workload | 150h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 2 weekly |
| Exercises | 2 weekly |
| **Number of positions** | |

## Summary

This course provides an overview of advanced techniques for solving large-scale linear algebra problems, as they typically arise in applications. A central goal of this course is to give the ability to choose a suitable solver for a given application.

## Content

**Introduction**
Sources of large-scale linear algebra problems. Recap of required linear algebra concepts.
**Eigenvalue problems**
Krylov subspace methods. Singular value problems. Preconditioned iterative methods.
**Linear systems**
Direct sparse factorizations. Krylov subspace methods and preconditioners.
**Matrix functions**
Theory and algorithms.

## Keywords

linear systems, eigenvalue problems, matrix functions

## Learning Prerequisites

### Required courses

Linear Algebra, Numerical Analysis

## Learning Outcomes

By the end of the course, the student must be able to:

- Choose method for solving a specific problem.
- Prove the convergence of iterative methods.
- Interpret the results of a computation in the light of theory.
- Implement numerical algorithms.
- Describe methods for solving linear algebra problems.
- State theoretical properties of numerical algorithms.

## Teaching methods

Ex cathedra lecture, exercises in the classroom and with computer

## Expected student activities

Attendance of lectures.
Completing exercises.
Completing a miniproject.
Solving problems on the computer.

## Assessment methods

Miniproject and oral examination.
Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

## Resources

### Bibliography

Lecture notes will be provided by the instructor. Complimentary reading:
H. Elman, D. J. Silvester, and A. J. Wathen. Finite elements and fast iterative solvers: with applications in incompressible fluid dynamics. Oxford University Press, 2005.
G. H. Golub and C. Van Loan. Matrix computations. Johns Hopkins University Press, 1996.
Y. Saad. Iterative methods for sparse linear systems. Second edition. SIAM, 2003.

### Ressources en bibliothèque

- Finite elements and fast iterative solvers / Elman
- Matrix computations / Golub
- Iterative methods for sparse linear systems / Saad

### Moodle Link

- https://go.epfl.ch/MATH-453