High Performance Linear Algebra

Iterative Solvers for Sparse Linear Systems

Ph.D. program in High Performance Scientific Computing

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General Info

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This course will give you an introduction to iterative solvers for sparse matrices, covering:

- General intro to iterative methods;
- Krylov Projection Methods;
- Sparse Matrices;
- Software Issues;
- Preconditioning;
- PSCToolkit: a software package for iterative solvers.

Essential texts: [2, 4]
Additional resources: [1, 3, 5]

General Info

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The course will require you to:

- Get acquainted with the theory;
- Gain some hands-on experience with writing software for sparse matrices;
- Delve into the parallelization techniques;
- Gain familiarity with existing software;
- Write your own application.

The **exam** will consist in a **project work** to be presented at the end of the course. This should be about applying existing tools to a problem of interest for your doctoral trail, or implementing some variation on existing code.

General Info

Timetable:

10/03/2026	2 hrs	13:00–15:00	Remote
12/03/2026	2 hrs	13:00–15:00	Remote
17/03/2026	2 hrs	13:00–15:00	Remote
19/03/2026	2 hrs	13:00–15:00	Remote
26/03/2026	4hrs/Full day	Morning (+ practical)	Presence (Pisa)
27/03/2026	4hrs/Full day	Morning (+ practical)	Presence (Pisa)

References

1 Bibliography

[1] R. Barrett et al. *Templates for the Solution of Linear Systems*. SIAM, 1993.

[2] G. H. Golub and C. F. Van Loan. *Matrix computations*. Fourth. Johns Hopkins Studies in the Mathematical Sciences. Johns Hopkins University Press, Baltimore, MD, 2013, pp. xiv+756. ISBN: 978-1-4214-0794-4.

[3] C. T. Kelley. *Iterative Methods for Linear and Nonlinear Equations*. SIAM, 1995.

[4] Y. Saad. *Iterative Methods for Sparse Linear Systems*. Second. Society for Industrial and Applied Mathematics, 2003. DOI: 10.1137/1.9780898718003. eprint: https://epubs.siam.org/doi/pdf/10.1137/1.9780898718003. URL: https://epubs.siam.org/doi/abs/10.1137/1.9780898718003.

[5] B. F. Smith, P. E. Bjørstad, and W. D. Gropp. *Domain decomposition. Parallel multilevel methods for elliptic partial differential equations*. Cambridge, UK: Cambridge University Press, 1996, pp. xii+224. ISBN: 0-521-49589-X.