ITERATIVE METHODS FOR LARGE-SCALE SADDLE POINT PROBLEMS

TENTATIVE PROGRAM (F. DURASTANTE)

(Cortona, 9–20 May, 2022)

Lecture schedule:

Lecture 1: An overview of Finite Element Methods.

Lecture 2: From variational crimes to mixed methods: the Stokes problem.

Lecture 3: Stabilization for the Stokes problem and the steady state incompressible Navier-Stokes equation.

Lecture 4: An overview of PDE Constrained Optimization: the Poisson problem with distributed controls.

Lecture 5: PDE Constrained Optimization: box-bounded controls and functionals with sparsity terms.

Lecture 6: An introduction to Multigrid Methods: the geometric multigrid for the Poisson equation.

Lecture 7: General theory of Algebraic Multigrid Methods (AMG) via 2×2 block factorizations.

Lecture 8: A gallery of AMG methods and some implementation issues: the exascale challenge.

Lecture 9: Laboratory session: implementing and testing preconditioners.

Lecture 10: Laboratory session: implementing and testing preconditioners; conclusions, discussion and perspectives.

Course prerequisites: A previous exposure to numerical analysis including numerical linear algebra, some familiarity with Lebesgue measure theory and bases of functional analysis, bases of programming with MATLAB/Python.

Selected references:

S. C. Brenner and L. R. Scott, *The Mathematical Theory of Finite Element Methods*, third edition, Texts in Applied Mathematics, 15, Springer, New York, 2008.

H. Elman, D. Silvester and A. Wathen, *Finite Elements and Fast Iterative Solvers, Second Edition*, Oxford Science Publication, 2014.

M. Hinze et al., *Optimization with PDE Constraints*, Mathematical Modelling: Theory and Applications, 23, Springer, New York, 2009.

P. S. Vassilevski, *Multilevel Block Factorization Preconditioners*, Springer, New York, 2008.