Background in Numerical Linear Algebra (Prof. M. Ferronato, University of Padova - frontal lessons, 4 h)

Matrix and vector calculus: eigenvalues and eigenvectors, norms, subspaces, Range and Kernel. Gram-Schmidt orthogonalization and Modified Gram-Schmidt algorithm. Householder projection. Projection operators: theoretical properties, matrix representation, orthogonal projections.

Numerical Linear Algebra (Prof. L. Bergamaschi, University of Padova - frontal lessons, 12 h)

Stationary methods for linear systems. Gradient methods for symmetric positive linear systems: Steepest Descent, Conjugate Gradient, acceleration of the Conjugate Gradient method. Non-symmetric linear systems: Generalized Minimal Residual (GMRES), practical GMRES implementation. Iterative methods based on Krylov subspaces projections. Non-linear problems: Newton, Quasi-Newton and Inexact Newton iterations.

Introduction to the Finite Element Method (Prof. M. Ferronato, University of Padova - frontal lessons, 14 h)

Second-order linear partial differential equations: classification (elliptic, parabolic and hyperbolic problems), well-posed problems, boundary and initial conditions. Variational principles: functionals, equations of Eulero-Lagrange. Variational methods: Ritz, Galerkin and Petrov-Galerkin methods, variational methods as projection in function spaces, weak formulations, weighted residuals. Finite elements: 1-D, 2-D and 3-D lagrangian elements, serendipity elements, triangular and tetrahedral elements. Finite element solution of Poisson equation. Finite element solution of the transient heat equation. Finite element solution of the transport equation.

Suggested books

Y. Saad. *Iterative Methods for Sparse Linear Systems*. SIAM, Philadelphia (PA), 2003
G. Gambolati, M. Ferronato. *Lezioni di Metodi Numerici per l'Ingegneria*. Libreria Progetto, Padova, 2015
Notes from the lectures