

# Mathematical Methods for Engineering

## Lecturers

Prof. **Alberto Valli** and Prof. **Ana Alonso Rodriguez**

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University of Trento, Italy

## Dates and venue

**Dates:** from Monday February 19, 2018 to Friday March 2, 2018

**Venue:** University of Trento, Department of Civil, Environmental and Mechanical Engineering (via Mesiano 77, I – 38123 Trento, Italy)

## Contents

### Theory

- Partial differential equations (elliptic equations, parabolic equations, hyperbolic equations, boundary value problems).
- Separation of variables (solution of heat and wave equations by means of Fourier expansion, orthonormal bases, Sturm-Liouville problems, Bessel functions, Legendre and Chebyshev polynomials).
- Fundamental solutions and Green functions for elliptic equations (Dirac delta "function", distributions, fundamental solutions, Green functions, integral representation formula in terms of the Green function).
- Integral equations and the boundary element method for elliptic problems (Green formulae, interior and boundary integral representation formulae in terms of the fundamental solution, integral equation on the boundary, collocation and Galerkin formulations of the boundary element method, algebraic structure of the approximating problems).
- Weak formulation and the finite element method for elliptic problems (minimization problems, Euler equation of a functional, weak formulation, Lax-Milgram lemma, existence and uniqueness of the solution, Galerkin approximation, finite element methods and spectral methods, family of triangulations and basis functions, Céa lemma and error estimates, mixed formulation and Stokes problem, mixed finite element methods, Ladyzhenskaya-Babuska-Brezzi condition and error estimates, compatible choices of finite elements, algebraic structure of the discrete problems, other applications).

### Tutorials

- The boundary element method: remarks on programming.

- The finite element method, 1 (classical formulations) & programming
- The finite element method, 2 (mixed formulations) & programming
- FreeFEM: an example of finite element software.

**Lessons:**

Monday 19, 14.30-17.30

Tuesday 20, 9.30-12.30 + 14.30-15.30

Wednesday 21, 9.30-12.30 + 14.30-15.30

Thursday 22, 9.30-13.30

Friday 23, 9.30-13.30

Monday 26, 9.30-12.30

Tuesday 27, 9.30-12.30

Wednesday 28, 9.30-12.30

Thursday 1, 9.30-12.30

Friday 2, 9.30-12.30

**Tutorials:**

Thursday 22, 15.30-17.30

Friday 23, 15.30 - 17.30

Monday 26, 14.30-17.30

Tuesday 27, 14.30-17.30

Wednesday 28, 14.30-17.30

Thursday 1, 14.30-17.30

**Exam: Friday 2, 14.30-17.30**