.

Special Functions and Applications

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Timetable: 24 hrs, First lecture on January 7, 2025, 10:30 (dates already fixed, see Calendar of Activities on https://dottorato.math.unipd.it/calendar/, Torre Archimede, Room 2BC30.

Credits: 4

Course requirements:
Basic notions of analysis and algebra, ordinary differential equations and partial differential equations

Examination and grading: Oral examination on the program and on a student's project

SSD: MAT/07

Aim: To present various families of special functions, their emergence and usefulness in applied mathematics contexts.

Course contents:

- Recap of basic facts in complex analysis: holomorphic functions, Laurent series, contour integrals, Cauchy theorem. Euler's Gamma function.
- The Probability Integral: from error estimates to heat conduction and boundary layers
- The Heat equation and Laplace transform
- Legendre and Hermite polynomials: Schrödinger equation and the quantum harmonic oscillator.
- Curvilinear coordinates. Laplace equation, separation of variables. Laguerre polynomials.
- Polar coordinates and spherical harmonics: the orbitals of the hydrogen atom.
- Cylindrical coordinates and Bessel functions: vibration of a membrane and the bi-harmonic Stokes problem.
- Further applications (or functions) can be selected based on the audience (possible topics in fluid mechanics, potential theory, stochastic analysis, numerical solution of PDEs).

Bibliography:

[1] N. N. Lebedev, Special Functions and Their Applications, Prentice–Hall, 1965.

[2] G. Arfken, Mathematical Methods for Physicists, 3rd ed., Academic Press, 1985.

[3] I. S. Gradshteyn, I. M. Ryzhik, Table of Integrals, Series, and Products, 7th ed., Elsevier, 2007