Partial Differential Equations of Mathematical Physics. An introduction.

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This course is designed as a first-year graduate course for Pure/Applied Mathematics, Physics and Engineering students. Its purpose is to introduce some of the main ideas involved in the derivation and analysis of the basic equations of Mathematical Physics. These include Laplace/Poisson equations of Potential Theory, equations describing linear/nonlinear diffusion, wave equations and others.

It is my goal to present some fundamental principles and tools without all the technicalities that often discourage those willing to get acquainted with the subject. Most results will be proved in the simplest possible setting and using rather intuitive and geometric arguments. On the other hand, a different perspective will be given on certain topics. Thus, in the theory of first order equations, more emphasis is put on the underlying simplectic and contact geometries than what is customary in PDEs textbooks. A historical perspective will be given on some of the topics and connections to finite-dimensional Analysis will be established. The main topics are

- First-order PDEs and characteristics: wave-particle duality.
- The Fourier method for the vibrating string.
- The Variational Principle in the theory of oscillations. The theory of small oscillations.
- Harmonic functions and their properties.
- Potential theory. Newtonian, single and double layer potentials.
- Boundary value problems for Laplace and Poisson equations.
- The heat equation and its connection to Brownian motion.

• **Prerequisites:** One and several variables Calculus, Linear Algebra and basic Ordinary Differential Equations.

• **Evaluation:** Will be based on the solution of a set of homework problems.

• **Text:** Although other sources will be used for certain topics, I will closely follow the book

- V. I. Arnold, Lectures on Partial Differential Equations, Universitext.