

*Title: Mathematical Methods for Theoretical Physics.*

*Lecturer: Andrea Bevilacqua*

*ECTS points: 3*

*The course will be focused on the discussion of some of the main mathematical tools used in Theoretical Physics, investigating both their properties and their use in physics. The course will be organized along two directions, proceeding in parallel.*

*In the first, we will introduce and study the concepts of manifold (as well as calculus on manifolds) , Lie group, and fibre bundle. Each of these topics is very rich, both from the mathematical and physical point of view. The aim is to give a more intuitive understanding of these mathematical tools.*

*In the second direction, we will apply what we have learned to physics. Many areas of physics are more easily understood using the formalism developed along the first direction. Some examples are the Lagrangian and Hamiltonian formalism in point mechanics, electrodynamics, gauge theories, and general relativity.*

*The aim of the course is to gain familiarity with such mathematical tools and their use in physics, emphasizing their power and generality in the description of physical theories.*

*The course consists of 30 hours of lectures, delivered in two-hour sessions over 15 weeks. Weekly exercises will be provided, the successful completion of which will contribute to the final grade. These exercises are designed to help students familiarize themselves with the course material through practical calculations. The final exam will be a take-home project, to be completed over one week, followed by an oral presentation of the results.*