

Minimal Surfaces

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Minimal surfaces are fascinating objects: in the physical world, they arise as soap films; in Mathematics, they have been introduced by Lagrange, who tried to find surfaces of “least area”. Finding explicit examples of minimal surfaces without self-intersections is an extremely difficult task, and 200 years after Lagrange, only a few are known. The study of minimal surfaces combines many areas of Mathematics, such as: Complex Analysis, Differential Geometry, Topology, and P.D.E. More recently, minimal surfaces have proved to be relevant for the study of 3-dimensional manifolds.

In the first part of the project, you will understand how to construct some known examples of minimal surfaces, by Complex Analysis techniques. Some time may be devoted to study and draw these surfaces on a computer, as it provides useful insights. The second part will concern the topology of minimal surfaces of “finite curvature”. Other possible additional topics (if time allows): a non-existence result for minimal graphs, examples of minimal surfaces on the sphere, and Willmore surfaces.

Prerequisites: good knowledge of Complex Analysis and Multivariable Calculus. Some knowledge in geometry of curves and surfaces will be very helpful, but is not required (relevant concepts will be recalled in an introduction session). Some basic knowledge of algebraic topology (Euler characteristic, classification of surfaces) will be helpful.