Course Description

This course introduces rigorous methods to study partial differential equations such as existence theory and global behavior of solutions. The goal is to understand intuitively PDEs and then to develop analytic skills to prove results. This class is intended to be spread over two semesters, the first semester will be focused on linear PDEs (e.g. elliptic, parabolic equations) and the second semester on non-linear PDEs (e.g. conservation laws, reaction diffusion).

The course is divided into three parts:

a) **Introduction** (*chap. 3*): we will review some examples of first order non-linear PDEs (conservation laws, Hamilton Jacobi) and study formally their behaviors.

b) **Nonvariational methods** (*chap. 9.1-9.3*): fixed point methods to solve non-linear elliptic equations (e.g. \(-\nabla \cdot (a(\nabla u)) = f\)) and reaction-diffusion (i.e. \(\partial_t u = \Delta u + f(u)\)).

c) **Systems of conservation laws** (*chap. 11*): Traveling waves solution to systems \(\partial_t u + \partial_x f(u) = 0\), entropy conditions.