Mathematical Modeling: Forward and Inverse Problems in Seismology

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Timetable: 16 hrs. First lecture on June 3, 2019, 16:00, (dates already fixed, see calendar), Torre Archimede, Room 2BC/30.

Course requirements: Students are expect to have a comfortable familiarity with
- Linear algebra
- Tensor algebra and calculus
- Distributions
- Ordinary and partial differential equations
- Differential geometry
- Continuum mechanics
- Numerical issues of nonlinear processes.

However, each subject will be sufficiently reviewed—based on the course needs—to provide the necessary background.

Examination and grading: Brief presentation on a course-pertinent subject, Oral examination/discussion

SSD: MAT/07-08: Mathematical Modeling

Aim:
- To familiarize the students with the mathematical wealth and complexities of problems encountered in quantitative seismology.
- To examine the meaning of mathematical entities and models used as analogies for physical objects and phenomena
- To understand limitations imposed by assumptions and approximations on predictions provided by forward problems
- To recognize, and deal with, unavoidable issues of inverse problems, such as singularities and nonuniqueness

Course contents:

1. Rudiments of continuum mechanics
    - Reference and current configurations
    - Finite and infinitesimal elasticity theory
    - Balance principles
    - Constitutive equations
    - Material symmetry
2. Equations of motion in isotropic homogeneous continua
    - Wave equations

- Solutions of wave equations (including weak solutions)
- Surface, guided and interface waves

3. Equations of motion in anisotropic inhomogeneous continua
    - Christoffel equations
    - Hamilton equations
    - Lagrange equations
    - Legendre transformation and its singularities
    - Characteristic equations of linear and nonlinear PDEs
    - Caustics
4. Variational principles in seismology
    - Fermat's principle
    - Hamilton's principle
5. Foundational issues of modeling
    - Prediction versus explanation
    - Underdetermination of theory by evidence
    - Falsicationism