

Discuss one of the following subjects at your choice, giving a detailed treatment of the concrete examples involved.

- 1) Describe the motion of an harmonic oscillator in  $R^2$  both in cartesian coordinates and in polar coordinates. Motivated by this example, introduce canonical transformations and the Hamilton-Jacobi method.
- 2) Describe the motion of a pendulum in a vertical plane. Motivated by this example, discuss in general the action-angle variables and complete integrability.
- 3) Describe in quantum mechanics the motion of a free particle on the line. Motivated by this example, compare the Schroedinger and the Heisenberg pictures and introduce the definition and the properties of the evolution operator.
- 4) Describe through an example the concept of thermodynamic limit.