UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Classical Mechanics

1920-2-E3001Q003

Aims

The basic ideas of Classical mechanics, from the Galileo-Newton formulation to those of Lagrange, Hamilton and Jacobi will be presented. The necessary mathematical tools for a proper comprehenson of these fundamental theories will be introduced and discussed.

Contents

Newtonian Mechanics (a reminder).

Second order differential equations. Qualitative analysis.

Lagrangian Mechanics.

Hamiltonian mechanics.

Detailed program

1) Space-time and events. Newton's principia and the dynamics of point masses.

2) Dynamical systems as mathematical models for physical phenomena. Basic aspects of the theory of second order Ordinary Differential Equations. Phase diagrams of conservative Newtonian systems in one dimension. The Lotka-Volterra system and Volterra's laws. Bifurcation diagrams. Linearization of a dynamical system around an equilibrium point. Stability and the theorems of Lyapunov (statement).

3) Dynamics of systems of point masses.

4) Constraints, degrees of freedom, and free coordinates. The D'Alembert principle and Lagrangian Mechanics.

5) The Lagrangian and the Euler-Lagrange equations. Variational principles. Central motions and the Kepler problem. Lagrangian formulation of the Lorentz force. Theory of small oscillations. Further applications. Noether's theorem. Basic notions of the theory of rigid bodies. Applications: rigid bodies in the plane. The Lagrange top.

6) Hamiltonian Mechanics: Hamilton equations and their variatiional formulation. Canonical transformations. Poisson brackets and constants of the motion. Infinitesimal canonical transformations and Noether's theorem in Hamiltonian Mechanics.

7) Liouville theorem on the conservation of volume in phase space. The Hamilton-Jacobi equation. Complete integrals. Introduction to the notion of separation of variables

Prerequisites

The content of the courses of Calculus I, Linear Algebra and Geometry, Physics I.

Teaching form

- Lectures (5 CFU)

- Classes (3 CFU)

Textbook and teaching resource

References:

L.D. Landau, E.M. Lifshits, "Course of Theoretical Physics, Vol. I: Mechanics" (Pergamon)

H Goldstein, C. Poole, J. Safko, "Classical Mechanics".

Lecture Notes available on the web page (http://www.matapp.unimib.it/~falqui/MC/mecc.html).

Notes of (some of) the lectures, available on the e-leraning page.

Semester

First semester

Assessment method

Written and Oral examination. The written examination consists in the solution of significant problems in Dynamical Systems, Lagrangian Mechanics and Hamiltonian Mechanics. Two written examinations concerning parts of the syllabus will be held during the course.

The oral examination consists in the discussion of the written part, as well as the discussion of fundamental topics of the course. Questions will be chosen (by the instructor) from a list to be given to the students at the end of the lectures.

Office hours

Meetings with individual students or small groups thereof are to be agreed via e-mail or e-learning