UCLouvain

lmat1261

2025

Lagrangian and Hamiltonian mechanics

The version you're consulting is not final. This course description may change. The final version will be published on 1st June.

5.00 credits	22.5 h + 30.0 h	Q1

Teacher(s)	Walmsley Hagendorf Christian ;
Language :	French > English-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Mathematical analysis courses LMAT1121 and LMAT1122, linear algebra course LMAT1131, mathematical physics course LMAT1161. Proficiency in the French language at the senior high school level.
Main themes	Lagrangian mechanics. Variational principles in analytical mechanics and canonical formalism. Symmetries and conservation laws. Solid body motion.
Learning outcomes	**At the end of this learning unit, the student is able to :** **Contribution of the course to the learning outcomes of the bachelor's degree program in mathematics.** **By the end of this activity, the student will have progressed in his/her ability to :** (a) Know and understand a fundamental foundation of mathematics. In particular, he/she will have developed the ability to : • i. Select and use fundamental computational methods and tools to solve mathematical problems. • ii. Recognize the fundamental concepts of some current mathematical theories. • iii. Establish the major connections between these theories, explain and motivate them with examples. (b) Identify, through the abstract and experimental approach of the exact sciences, the unifying aspects of different mathematical situations and experiences. 1 (c) Demonstrate abstraction and critical thinking skills. In particular, the student will have developed the ability to: • i. Recognize the key arguments and structure of a demonstration. • ii. Distinguish between the intuition of the validity of a result and the different levels of rigorous understanding of the same result. **Course Specific Learning Outcomes.** **At the end of this activity, the student will be able to :** • (a) Write the Euler-Lagrange equations for a system with several degrees of freedom. • (b) Solve elementary variational problems, be familiar with the Hamiltonian formalism. • (c) Determine and exploit the symmetries of a mechanics problem to describe its motion and characteristics. • (d) Describe and analyze solid body motion.
Evaluation methods	The evaluation is based on a written exam and a continuous evaluation conducted during the semester. The written exam focuses on theoretical concepts and their application to analytical mechanics problems. It tests the understanding of the concepts seen in the course, the ability to analyze an analytical mechanics problem through mathematical modeling, the mastery of computational techniques and the coherent presentation of solutions. The result of the continuous assessment will be used for each session and cannot be represented.
Teaching methods	The learning activities consist of lectures and practical sessions. The lectures aim to introduce the fundamental concepts, to motivate them by giving examples and establishing results, to show their reciprocal links and their relationship with other courses in the Bachelor's program in mathematical and physical sciences. The practical sessions aim to learn how to model physical problems, choose and use computational methods for their analysis and interpret the results obtained.

Content	The aim of LMAT1261 is to present an overview of the concepts of analytical mechanics. The course's topics play an important role in other disciplines of the bachelors in physics and mathematics. Their presentation is adapted to the students of both these bachelors. The course treats the following topics : **Lagrangian mechanics:** Newtonian mechanics (reminder), Lagrangian equations and constraints, Hamilton's principle, elements of variational calculus, symmetries and conservation laws. **Hamiltonian mechanics:** Legendre transformation, canonical equations, Poisson brackets, canonical transformations, elements of Hamilton-Jacobi theory.
Inline resources	The course's Moodle website provides lecture notes, exercise sheets, a detailed syllabus and an ample bibliography.
Bibliography	• Arnold, Mathematical methods of classical mechanics. Springer 1989. • Fomin, *Calculus of variations.* Dover Publications 2000. • Morin, *Introduction to Classical Mechanics: With Problems and Solutions.* Cambridge University Press 2008. • Nolting, *Theoretical Physics 2: Analytical mechanics.* Springer-Verlag 2016.
Faculty or entity in charge	SC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Additionnal module in Mathematics	APPMATH	5		
Minor in Mathematics	MINMATH	5		
Bachelor in Mathematics	MATH1BA	5		
Bachelor in Physics	PHYS1BA	5		
Master [120] of Education, Section 4 : Physics	PHYS2M4	5		