UCL Université catholique de Louvain

LMAT1261

2015-2016

Mathematical methods of classic mechanics 2

5.0 credits	22.5 h + 30.0 h	1q

Teacher(s) :	Hagendorf Christian ; Haine Luc ;
Language :	Français
Place of the course	Louvain-la-Neuve
Inline resources:	iCampus website (> http://icampus.uclouvain.be/, requires identification). The website provides a course outline, lecture notes, a detailed bibliography, as well as all problem sets for the exercise sessions.
Prerequisites :	Calculus LMAT1121 and LMAT1122, linear algebra LMAT1131, analytical mechanics LMAT1161. Language skills : French (written and spoken) at high school level. *The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.*
Main themes :	Small oscillations. Variational methods in analytical mechanics and the canonical formalism. Symmetries and conservation laws. Rigid body dynamics.
Aims :	Contribution of the course to learning outcomes in the Bachelor in Mathematics programme. By the end of this activity, students will have made progress in: - Recognise and understand a basic foundation of mathematics. In particular : -- Choose and use the basic tools of calculation to solve mathematical problems. -- Recognise the fundamental concepts of important current mathematical theories. -- Establish the main connections between these theories, analyse them and explain them through the use of examples. - Identify, by use of the abstract and experimental approach specific to the exact sciences, the unifying features of different situations and experiments in mathematics or in closely related fields (probability and statistics, physics, computing). - Show evidence of abstract thinking and of a critical spirit. In particular : -- Recognise the key arguments and the structure of a proof. -- Distinguish between the intuition and the validity of a result and the different levels of rigorous understanding of this same result. Learning outcomes specific to the course. By the end of this activity, students will be able to: - Analyse equilibrium points of mechanical systems and describes small oscillations in their vicinity. - Solve elementary variational problems. - Apply the Hamiltonian formalism to mechanical problems. - Determine the symmetries of a mechanical system and use them in order to describe its evolution. - Determine the motion of rigid bodies. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods :	Assessment is based on a written examination focusing on theoretical concepts and their application to problems in theoretical physics. The examination tests knowledge and understanding of concepts from the course, ability to analyse a problem in analytical mechanics through mathematical modelling, mastery of the techniques of calculation, and the coherent presentation of this analysis. Active participation in exercise sessions may supply a bonus of a maximum of 2 points out of 20 which are added to the examination grade.
Teaching methods :	Learning activities consist of lectures and exercise sessions. The lectures aim to introduce fundamental concepts, to explain them by showing examples and by determining their results, to show their reciprocal connections and their connections with other courses in the programme for the Bachelor in Mathematics and Physics. Exercise sessions aim to teach the modelling of problems in physics, the selection and use of calculation methods for their analysis and the interpretation of the results obtained.
Content :	This course is a followup of LMAT1161 - Analytical mechanics 1, and aims at generalising its concepts. The course topics play an important role within the Bachelor of Mathematics and Bachelor in Physics programme : topics such as the Euler-Lagrange equations, Legendre transforms, the canonical formalism have various applications in geometry and analysis, but also in quantum mechanics and statistical physics. A central theme is the study of symmetry and its use to solve problems. The following points are treated in the course. - Small oscillations : the concept of equilibrium points, linearisation of the equations of motion, (coupled)harmonic oscillators, eigenmodes, oscillator chains and their continuum limit, the wave equation. - Variational principles and the canonical formalism : examples of variational problems in mathematics and physics, functionals and first variation, Euler-Lagrange equations, Legendre transformation, Hamiltonian and Hamilton's equations, Poisson brackets, canonical transformations.

	- Symmetries and conservation laws : invariance under translations in time, spatial translations and rotation, and associated conservation laws, cyclic coordinates, one-parameter families of symmetry transformations and Noether's theorem, similarity laws in mechanics. - Rigid body motion : kinematics of rigid bodies, co-moving frames, tensor of inertia, Lagrangian description, Euler's equation, Euler angles, motion of spinning tops.
Bibliography :	Lecture notes and a detailed bibliography can be found on iCampus. Main references: - Arnold : Mathematical methodes of classical mechanics. Springer-Verlag 1997. - Gelfand, Fomin : Calculus of variations. Dover Publications 2000. - Goldstein : Classical mechanics. Addison-Wesley 2007. - Landau, Lifshifts : Cours de physique théorique. Tome 1, édition Mir 1994.
Faculty or entity in charge:	MATH

Programmes / formations proposant cette unité d'enseignement (UE)

Intitulé du programme	Sigle	Credits	Prerequis	Acquis d'apprentissage
Bachelor in Physics	PHYS1BA	4	LMAT1131 **and** LMAT1122 **and** LMAT1121 **and** LMAT1161	
Minor in Mathematics	LMATH100I	5	-	
Bachelor in Mathematics	MATH1BA	5	LMAT1121 **and** LMAT1122 **and** LMAT1131 **and** LMAT1161	