UCLouvain

lphys1231

2024

Special Relativity

5.00 credits	30.0 h + 15.0 h	Q2

Teacher(s)	Drewes Marco ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	It is recommended that students master the basics of classical mechanics as developed in the course LPHYS1111. Having passed LPHYS1221 is an asset.
Main themes	This teaching unit is a basic introduction to Einstein's ***special relativity*** . The main themes tackled are geometry in space-time, kinematics and relativistic dynamics.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 **a. Contribution of the teaching unit to the learning outcomes of the programme** **AA1 :** 1.1, 1.3, 1.4 **AA2 :** 2.1, 2.4 **AA3 :** 3.2, 3.5 **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able : 1. to handle the concepts of metrics and invariants (from Euclid to Minkowski); 2. to go beyond classical prejudices as simultaneity is currently entirely relative and the addition of non-linear velocities (from Galileo to Einstein); 3. to move from an algebraic approach (Lorentz transformation as applied to a four-vector) to a geometric interpretation (in Minkowski's space-time) to describe phenomena such as time dilation and length contraction; 4. to apply relativistic formalism to particle disintegrations (at rest or in motion) and to elastic collision processes (Compton scattering, etc.) and inelastic collision processes (Mossbauer effect, etc.); 5. to apply relativistic formalism to gravitation (starting from a uniform acceleration motion) and to electromagnetism (starting from the Lorentz force); 6. to fully appreciate the impact (in the very long term) of fundamental research that feeds today's applied research.
Evaluation methods	Written exam including questions on the development of concepts in physics (from Euclid to Mikowski, from Galileo to Einstein, from Newton to Einstein) and their coherent mathematical formulation (from vectors to tensors).
Teaching methods	Apply physics and mathematics theories to resolve a problem. We start from the principle that physics is a coherent representation of reality whose truth value rests upon FACTS to illustrate systematically, through phenomena observed in nature, all concepts inherent to the theory of special relativity. Consequently, we choose : - lecture presentations of theory with, in parallel, many applications in physics; - exercise sessions covering other physics applications. Justify the choice of methods and analysis tools used to solve known problems in physics. Incoherence between Newton's mechanics and Maxwell's theory will lead to the development of a covariant theory with respect to the Lorentz transformations. Various exercises on the new mathematical objects that are the tensors will be proposed and solved. Construct a physics argument and formalize it. Development of concepts in physics and an introduction to new formalisms: - from space-time geometry to Lorentz transformations; - from relativistic kinematics to tensors; - from relativistic dynamics to interaction fields.
Content	The main themes addressed are : 1. Geometry in space-time: from rotation in a homogenous space to pseudo-rotation in causal space-time; 2. Relativistic kinematics: from Newton's first law (inertia) to conservation of the four-vector energy-momentum; 3. Relativistic dynamics: from Newton's second law (force) to the existence of electromagnetic (four-vector) and gravitational (tensor) fields.

Bibliography	« Relativité: Fondements et applications (avec 150 exercices et problèmes résolus) », J.-P. Perez (Dunod, Paris, 1999) ; « A student's guide to vectors and tensors », D. Fleisch (Cambridge, 2012).
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Minor in Physics	MINPHYS	5		🔍
Master [120] in Physical Engineering	FYAP2M	5		🔍
Bachelor in Physics	PHYS1BA	5		🔍