UCLouvain

lepl1203

2023

Physics III

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	. SOMEBODY ;Charlier Jean-Christophe ;Louveaux Jérôme ;Oestges Claude (coordinator) ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	This course assumes acquired the notions of mathematics and physics such as taught in the courses **LEPL1101, LEPL1102, LEPL1105 , LEPL1201 et LEPL1202**
Main themes	Two topics are covered: • The course deals with wave physics, with a special emphasis on electromagnetic waves. It starts by writing Maxwell's equations, followed by a derivation of the wave equation from Maxwell's equations or from classical mechanics, and discusses its general solutions. The characteristics of simple waves are presented (frequency, wavelength, Doppler effect, polarisation,...). The behaviour of waves at the interface between two systems is then studied (Snell's and Fresnel's equations). Interference phenomena, including diffraction, are presented for local point and extended sources. Standing waves are then considered, as well as wave packets. The generation of electromagnetic waves is finally discussed (antennas and oscillating dipoles). • The second part of the course is an introduction to quantum physics: based on the notion of waves, it seeks to show the continuity and radical novelty of quantum physics compared to classical physics. It presents the limits of classical physics and the answer brought by quantum physics (wave-particle duality, Heisenberg uncertainty principle, Schrödinger equation), based on the concepts seen in the first part. It shows the interest of quantum physics in solving simple problems, and ends with a brief justification of the properties of atoms (hydrogen atom), providing a link to the notion of orbital necessary to understand chemistry and that of band structure used in solid-state physics.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 — **Contribution of the course to the program objectives**: Regarding the learning outcomes of the program of Bachelor in Engineering, this course contributes to the development and the acquisition of the following learning outcomes: • LO 1.1 • LO 2.7 • LO 3.2 • LO 4.2, 4.5 **Specific learning outcomes of the course:** At the end of the course, he student will be able : • To write Maxwell's equations for the electromagnetic field and to explain their different terms; • To derive the wave equation from Maxwell's or Newton's equations, and to give the general solution of the wave equation for an electromagnetic or a mechanical wave; • To identify the main characteristics of a periodic wave (frequency, wavelength, speed), and the consequences of the Doppler effect on them; • To enumerate the possible polarizations for various waves, and to represent a wave of given polarization by an appropriate mathematical expression; • To define, explain and provide a mathematical justification for the following effects : refraction, reflection, interference (in the Fraunhofer approximation), diffraction, standing waves, beating; • To explain in simple words the origin of the electromagnetic radiation, and to compute the radiation intensity away from an elementary source; • To explain in simple words the limits of classical physics and the need for quantum physics; • To describe with quantum mechanics the behavior of particles in a flat potential, in a potential well, close to a potential barrier, as well as the tunnel effect and the atomic structure of the hydrogen atom; • To use the mathematical expressions describing the effects dealt with in the course in order to solve numerically small problems involving these effects; to characterize experimentally some of these effects.
Evaluation methods	Evaluation is based upon: • a written exam at the end of the quadrimester (students are provided for the exam with a reference formula sheet available for download on the course website) • the mandatory participation to the laboratories (1 point penalty for each non-justified absence) • possibly, a mid-quadrimester test (in any case, non mandatory and non certificative).

Teaching methods	Lectures (CM). Learning based on exercises (APE), problems (APP) or laboratory (LABO) work by groups of students.
Content	Waves 1.1. Displacement current' integrated approach of electromagnetism 1.2. Maxwell's equations and the wave equation 1.3. Solutions to the wave equation; mechanical waves 1.4. Polarization; reflection et refraction 1.5. Interferences 1.6. Diffraction 1.7. Standing waves and wave packets 1.8. Electromagnetic radiation and antennas Quantum Physics 2.1 Wave-particle duality, Heisenberg Uncertainty Principle 2.2 Schrödinger's equation and wave function 2.3. Quantum particles, potential wells and the tunneling effect 2.4. Hydrogen atom model and crystal band structure This teaching unit also tackles issues linked to sustainable development and transition during a problem-based learning session (linked to the recovery of solar energy via the calculation of solar power density on earth), as well as during the last course of the first part, where the issue of electromagnetic radiation is tackled (definition of field levels, comparison with Belgian legislation on mobile phone networks, etc.).
Inline resources	Moodle: https://moodleucl.uclouvain.be/course/view.php?id=7223
Faculty or entity in charge	BTCI

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Bachelor in Engineering	FSA1BA	5		🔍