LFSAB1203

2015-2016

PHYSICS 3

5.0 credits	30.0 h + 30.0 h	1q

Teacher(s) :	Oestges Claude ; Louveaux Jérôme ; Charlier Jean-Christophe ;
Language :	Français
Place of the course	Louvain-la-Neuve
Inline resources:	> http://moodleucl.uclouvain.be/course/view.php?id=7223
Prerequisites :	*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 :	Two themes are considered : -- The first theme 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 theme introduces quantum physics and demonstrates the continuity and sheer novelty of quantum physics with respect to classical physics. It presents the limitations of classical physics, and the concepts developed in quantum physics to solve these limitations (Wave-particle duality, Heisenberg's uncertainty principle, Schrödinger's equation). A few simple cases are solved (free particle, particle in a quantum well or near a potential barrier). The course ends with a description of atom properties (based on the model of the Hydrogen atom), in order to open to the notion of orbitals used by chemists, and of the band structure of crystalline solids as typically used in solid-state physics
Aims :	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. *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 :	Written exam at the end of the quadrimester; a mid-quadrimester interrogation is also organized; a public presentation by the students of their group work (APP or LABO) is also organized at the start of some lectures. The students are provided for the exam (and the interrogation) with a reference formula sheet available for download on the course website.
Teaching methods :	Lectures (CM). Learning based on exercises (APE), problems (APP) or laboratory (LABO) work by groups of students.
Content :	Part 1 : 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 Part 2 : Quantum physics 2.1. Wave-particle duality, Heisenberg's uncertainty principle 2.2. Schrödinger's equation and wave function 2.3. Quantum particles, potential wells and tunnel effect 2.4. The hydrogen atom and the band structure of crystals
Bibliography :	Slides, exercises and their solutions, laboratory notes, and pedagogical animations are available on the course website. The reference book is any recent edition of H. D. Young et R. A. Freedman, University Physics with Modern Physics, Addison Wesley: San Francisco.
Faculty or entity in charge:	BTCI

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

Intitulé du programme	Sigle	Credits	Prerequis	Acquis d'apprentissage
Bachelor in Engineering	FSA1BA	5	LFSAB1201 **and** LFSAB1202	