binge1243 — Conceptual Physics with technical Applications

2023

6.00 credits	60.0 h	Q1

This learning unit is not open to incoming exchange students!

Teacher(s)	Toussaint Sébastien ;
Language :	English
Place of the course	Bruxelles Saint-Louis
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.*
Learning outcomes	
Evaluation methods	Written closed-book exam (with form available) with three categories of questions: • A question evaluating the student's ability to deploy the scientific method (dimensional, vector-based and energy analysis) on a simple motion (projectile motion, inclined plane, spring, simple pendulum, etc.). The student is eventually asked to realize predictions (30%). • A series of multiple-choice conceptual questions. These questions evaluate the student's ability to **identify** the relevant **concepts** required to explain an observation and present a **justification** (35%) • A series of exercises. These questions evaluate the student's ability to **solve** problems with numerical values (35%).
Teaching methods	Four hours a week are dedicated to INGE1243 during the semester: an ex-cathedra lecture (two hours) is followed by a session of two hours of exercise session. One (or two) topic is extensively presented ex-cathedra (e.g. the drag force, work-energy theorem, etc.) and the same topic is exemplified in the following exercise session. The exercises can be separated into three categories: synthesis questions, conceptual questions, and computational questions. During the session, the students are expected to work by themselves (alone or in small groups). Nevertheless, the teacher is fully available for four tasks: (1) answer clarification questions, (2) deliver tips to guide students (requesting them) towards the solution, (3) discuss the way the student justifies the answer and (4), if necessary, solve "tougher" problems on the board.
Content	In this course, students will develop the **methodological** approach to describe a physical phenomenon. The method is based on three building blocks: dimensional analysis, vector-based analysis (Newton's law of motion), and energy-based analysis (work-energy theorem). This course aims at bridging the gap between physics-based concepts and their real-world implementations in technologies. Students will strengthen their critical reasoning with the help of the scientific method to estimate the potential, feasibility, and the viability of technological projects. After attending this course, the student will be able to: • Master adequately orders of magnitudes and units. • Solve elementary physics problems. • Identify how these problems help to assess technological systems. • Explain, thanks to the relevant physical laws, the basic working principles underlying selected technologies. • Formulate concepts and insights in a scientific manner. The course is divided into **two parts** where each topic is presented with the associated technologies it supports. I) **Mechanics** • Chapter 1: Fermi questions, scaling, dimensions, units, and the scientific method Laws and principles, causality, international system of units, dimensional analysis and scaling, the orders of magnitude in various physical phenomena • Chapter 2: Kinematics: motion in one dimension Position, velocity, acceleration, motion with constant acceleration (free fall), projectile motion • Chapter 3: Coordinate systems, scalars and vectors Dot product, cross product, cartesian coordinates, rotations in the 2D plane. • Chapter 4: Kinematics: motion in two dimensions Polar coordinates, Angular velocity, Uniform circular motion.

	• Chapter 5: Dynamics: Newton's law of motion Free body diagram, forces, torques, linear and angular momentum, rolling on an inclined plane, gyroscope physics. • Chapter 6: Newton's third principle application - Drag Drag coefficient, terminal velocity, lift, rocket science. • Chapter 7: Work-energy theorem Potential and kinetic energy, energy conservation, dissipation • Chapter 8: Simple harmonic motions: Simple pendulum, spring, swing resonance, damping II) **Electricity and magnetism** - Chapter 9: Electric charge and electric field Fields, Static electricity, electrical charge, Coulomb's law, electric field, electrical potential energy - Chapter 10: Magnetism Compass physics, magnets, Lorentz force, cyclotron physics, cyclotron resonance (work-energy theorem)
Inline resources	Complementary notes related to each course are communicated online each week.
Bibliography	• Urone, P. P., & Hinrichs, R. (2012). College Physics (OpenStax). (**Reference book)** • Hewitt, Paul G. *Conceptual physics*. Pearson Education, 2002.
Other infos	The use of a simple (non-graphical and non-programmable) calculator is permitted. During the exam, a form (used during the exercises sessions) is at student's disposal.
Faculty or entity in charge	ESPB

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Bachelor of Science in Business Engineering	BBEB1BA	6	EINGE1134	🔍