

Faculty of Applied Sciences



FSAB1203 PHYSICS 3

[30h+30h exercises] 5 credits

This course is taught in the 1st semester

Teacher(s): Alain Jonas (coord.), Jean-Pierre Raskin, Jean-Claude Samin, Piotr Sobieski
Language: French
Level: First cycle

Aims

Introduction to wave physics and quantum physics. Complements of mechanics (rigid bodies).

At the end of their classes, students are expected to be able :

1. to describe the main characteristics and properties of waves, and to derive the wave equation starting from basic principles of electromagnetism and mechanics; to solve the wave equation for simple cases (plane waves, stationary waves, interfering waves, diffracted waves,...);
2. To use the principle of virtual powers to study the mechanics of multi-body systems; to derive Lagrange's equations from this principle;
3. To present the main limitations of classical physics; to write Schrödinger's equation and to connect it to classical mechanics (Hamilton's equations) and to electromagnetism (wave equation); to compute simple wave functions for a free particle, a particle near a potential barrier or in a potential well, an electron in a Hydrogen atom, etc.

Main themes

The course is divided in three parts. The first part (2 ECTS) deals with wave physics, with a special emphasis on electromagnetic waves; the second part (1.3 ECTS) is an introduction to the principle of virtual powers of classical mechanics; the third part (1.7 ECTS) introduces the student to quantum physics. The two first parts are logical sequels of courses FSAB 1201 (Physics I) and FSAB 1202 (Physics II). The third part makes use of notions developed in the first part (waves) and the second part (Hamilton's equations derived from Lagrange's equations) to demonstrate the continuity and sheer novelty of quantum physics with respect to classical physics.

The first part starts with 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, wavevector, polarisation,...). The behaviour of waves at the interface between two systems is then studied (Snell's and Fresnel's equations). Wave generation is then considered (antennas, oscillating dipoles, accelerated charge,...), and interference phenomena, including diffraction, are presented for local point and extended sources. Finally, stationary waves are considered.

The second part makes use of the principle of virtual powers to solve some mechanical problems of increasing complexity. Lagrange's equations are introduced at the end.

The third part presents the limitations of classical physics. The concepts developed in quantum physics to solve these limitations are presented (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.

3. Summary : content and methods

Part 1: Waves

- 1.1 Wave equation
- 1.2 Polarisation - reflection et refraction
- 1.3 Antennas et oscillating dipoles
- 1.4 Interferences (interferences from point sources; diffraction; stationary waves)

Part 2 : Principle of virtual powers and Lagrange's mechanics

Part 3 : Quantum Physics

- 1.1 Limitations of classical mechanics
- 1.2 Schrödinger's equation and wave function
- 1.3 Quantum particles
- 1.4 Model of the Hydrogen atom

Methods :

Problem-based learning, exercises, lectures, practical classes (part I only)

4. Prerequisites

FSAB 1201 (Physics 1) or a similar course.

FSAB 1202 (Physics 2) or a similar course.

FSAB 1101 (Mathematics 1) or a similar course.

FSAB 1102 (Mathematics 2) or a similar course.

Content and teaching methods

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Other information (prerequisite, evaluation (assessment methods), course materials recommended readings,

...)

The evaluation has 2 components: an intermediary evaluation during the quadrimester and a final exam at the end of the quadrimester (written exam). The final mark is a combination of the scores in these two evaluations

- Workfiles for each of the parts (available on the website and in printed version); Reference book: University Physics (Freedman and Young)

Other credits in programs

FSA11BA	Première année de bachelier en sciences de l'ingénieur, orientation ingénieur civil	(5 credits)	
FSA12BA	Deuxième année de bachelier en sciences de l'ingénieur, orientation ingénieur civil	(5 credits)	Mandatory