

Mechanics - Physics



ECTS credits
4 credits



Semester
Fall

In brief

> **Course language:** French

Presentation

Prerequisites

- 1st year course/ **Mechanics**: basics of continuum mechanics
- 1st year course/ **Physics**: statistical physics and quantum physics parts.
- 1st year course/ **Waves and Signal**: Maxwell, wave and Helmholtz equations, paraxial propagation, signal processing.
- Basics of group theory.

Learning objectives

- Use the 1st year programme to discover fundamental notions:
 - dynamics in mechanics;
 - in the case of optics, the formation of images and the transmission/retrieval of information using light;
 - in addition to the above, the course will also cover the following topics: - the concept of symmetry and variational calculus in relation to the Lagrange and Hamilton formalisms, for quantum physics.
 - fluctuations and critical phenomena for statistical physics.
- Know how to put a problem into equations using different tools.
- Know how to calculate theoretically or numerically the solutions of the different problems formulated.
- Know how to analyse the solutions obtained.

Description of the programme

The programme is divided into three parts of equal volume: mechanics, optics, and physics (quantum and statistical).

Mechanics:

- Equation tools:

- Virtual power theorem and opening to the finite element method
- Hamilton's principle and Lagrange's equations
- Resolution and analysis:
 - Transient and stationary regimes
 - Modes
 - Stability and bifurcations

Optics:

- Matrix methods for rays and waves, Collins formula and phase space
- Types of optical system (imaging, afocal, Fourier transforming), aberrations and optical resolution
- Waveguides (metallic, dielectric and gradient index)
- Lasers: stimulated emission, coherence, cavities, modes, short pulses, amplification of chirps

Quantum physics:

- Infinitesimal symmetries, Lie algebra of generators: Lorentz group, spinorial transformations of the SU2 group seen as a representation of the group of rotations in R^3
- Density matrix for qubits (Bloch vector), coherence and purity of a quantum state, links with optics
- Principle of least action

Statistical physics:

- Distribution theory and applications in physics
- Random fields applied to physics
- Equilibrium fluctuations and phase transitions

Generic central skills and knowledge targeted in the discipline

- Know the links and similarities between different disciplines
- Know how to put a large number of complex systems into equations
- Know how to solve a system of equations analytically
- Know the basics of numerical methods for solving the systems encountered
- Know how to analyse the solutions obtained
- Be able to solve simple problems as seen in courses or similar to them
- Deepen basic concepts such as the principle of symmetry

How knowledge is tested

CC1: written (42%)

CC2: written (42%)

CC3: mini-project in optics (8 %)

CC4: short tests at the beginning of each tutorial class (8 %)

Bibliography

- PDF version of slides, PDF and CDF notes
- Physics:

-- D. Griffith, Introduction to Quantum Mechanics, Wiley (available in electronic and paper version at the centre de documentation)
plus polycopie available on Moodle
-- Ph. Réfrégier, Noise theory and application to physics, Springer, 2003
-- J.M. Yeomans, Statistical Mechanics of Phase Transitions, Oxford Science Publications, 1992

Teaching team

Optics: *Miguel Alonso*, Luis Arturo Aleman Castaneda, Frédéric Lemarquis, Laurent Gallais-During
Quantum physics: *Thomas Durt* et Marc Jaeger
Statistical physics: *Philippe Réfrégier*, Georges Bérardi, Muriel Roche, Julien Fade
Mechanics: *Emmanuelle Sarrouy*, Bruno Cochelin, Régis Cottureau, Thierry Désoyer, Cédric Maury

Total des heures			72h
CM	Master class		36h
TD	Directed work		18h
TP	Practical work		2h
AA			14h
AU			2h

Useful info

Name responsible for EU

Lead Instructor

Emmanuelle Sarrouy

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