Mechanics - Physics

ECTS credits
4 credits

Semester
Fall

In brief

Course langage: 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 R3
• 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
Statisical physics: *Philippe Réfrégier*, Georges Bérardi, Muriel Roche, Julien Fade
Mechanics: *Emmanuelle Sarrouy*, Bruno Cochelin, Régis Cottereau, 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
emmanuelle.sarrouy@centrale-med.fr