

# Compléments de mathématiques

## Lecturer

Ignace LORIS (Coordinator)

## Course mnemonic

MATH-F214

## ECTS credits

5 credits

## Language(s) of instruction

French

## Course period

First term

## Campus

Plaine

## Course content

- 1) Legendre transformation, differential and implicit functions
- 2) Dynamical systems (modelling, phase plane, linear and nonlinear systems, Liouville theorem, numerical solutions)
- 3) Series and integral representations
- 4) Series and integral solutions of differential equations (Frobenius method)
- 5) Euclidean, hermitian and Hilbert spaces (Kronecker symbol, basis, linear operators, eigenvalues and vectors, commuting operators)
- 6) Fourier series (periodic functions, lattice and reciprocal lattice (also in 3D), properties, convergences, forbidden symmetries, numerical computation)
- 7) Fourier transformation (properties, gaussian function, inversion formula, sampling, relation with Fourier series)
- 8) Partial differential equations and diffusion (laplacian operator, heat equation, fundamental solution, separation of variables)
- 9) Hermite polynomials and quantum harmonic oscillator
- 10) Spherical harmonic functions (laplacian in spherical coordinates, harmonic polynomials, properties, Legendre polynomials)
- 11) Hydrogen atom (Laguerre polynomials, Schrödinger equation, central potential, complete solution)

## Objectives (and/or specific learning outcomes)

At the end of this teaching unit, a student will be able to

- 1) comprehend and manipulate Legendre transformations and the differential

- 2) model a temporal evolution with a dynamical system, solve a linear dynamical system, understand the phase plane and Liouville theorem
- 3) manipulate power series (exponential, geometric and binomial)
- 4) understand Frobenius method
- 5) verify if a function is an eigenfunction of a linear operator
- 6) write the Fourier series of a simple function, draw a latticed and reciprocal lattice in 2D
- 7) manipulate some Fourier integrals and draw some Fourier transforms in 2D
- 8) understand the notion of laplacian and a mathematical description of diffusion
- 9) manipulate Hermite polynomials
- 10) use spherical harmonic functions and Legendre polynomials
- 11) separate variables in the Schrödinger equation in spherical coordinates

## Pre-requisites and co-requisites

### Pre-requisites courses

MATH-F112 | Mathématiques 1 | 10 crédits and MATH-F115 | Compléments d'analyse et algèbre linéaire | 5 crédits

### Course having this one as co-requisit

CHIM-F304 | Structures et symétries moléculaires | 5 crédits

### Required knowledge and skills

General mathematics (cartesian coordinates, functions, derivatives, integrals, matrices, determinants)

## Teaching method and learning activities

Theoretical courses and exercises

### Contribution to the teaching profile

- Acquire, assimilate and exploit basic knowledge of mathematics, physics, chemistry, biology and geo-sciences
- Develop transversal knowledge
- Collect, analyse and synthesize knowledge
- Identify problems and formulate scientific questions
- Solve problems
- demonstrate intellectual openness

### References, bibliography and recommended reading

Syllabus for sale at PUB and available on UV (Moodle)

## Other information

### Place(s) of teaching

Plaine

### Contact(s)

Prof. Ignace Loris: Ignace.Loris@ulb.be, local 2.0.7.107, Teams, ...

## Programmes

### Programmes proposing this course at the faculty of Sciences

BA-CHIM | Bachelor in Chemistry | unit 2

