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, Liouvuille 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) comprenhend 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-requisits and co-requisits

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)

Course notes

Syllabus and Université virtuelle

Other information

Place(s) of teaching

Plaine

Contact(s)

Prof. Ignace Loris: Ignace.Loris@ulb.be, local 2.O.7.107, Teams, ...

Evaluation method(s)

written examination

Evaluation method(s) (additional information)

One integrated written exam of theory and exercices. Exceptionally (pandemic, open session, ...) the written exam could be replaced by an oral exam.

Determination of the mark (including the weighting of partial marks)

No partial marks. One mark out of 20.

Main language(s) of evaluation

French

Other language(s) of evaluation, if applicable

English

Programmes

Programmes proposing this course at the faculty of Sciences

BA-CHIM | Bachelor in Chemistry | unit 2