## Algebra 1

1. Course number and name: 020AL1CI2 Algebra 1
2. Credits and contact hours: 6 ECTS credits, $3 \times 1: 15$ contact hours
3. Name(s) of instructor(s) or course coordinator(s): Guilnard Sadaka
4. Instructional materials:
a. Textbook: Xavier Oudot : Maths MP/MP*, Vuibert.
b. Supplemental material : pdf course
5. Specific course information
a. Catalog description:

Algebraic structures, vector spaces, linear applications, matrices, determinants, linear systems, euclidean spaces.
b. Prerequisites: None
c. Required/Selected Elective/Open Elective: Required

## 6. Educational objectives for the course

a. Specific outcomes of instruction:

- Recognize an algebraic structure.
- Characterize a substructure.
- Manipulate elements of a group.
- Perform calculations in a ring.
- Calculate compositions of permutations, the order of a permutation, a signature.
- Demonstrate the algebraic structure of a vector space.
- Understand the notion of a vector subspace generated by a set.
- Show the linearity of a mapping.
- Master the definition, not only algebraic but also geometric, of projectors and symmetries.
- Determine a basis of a vector space and its dimension.
- Exploit properties of finite-dimensional vector spaces.
- Perform matrix calculations: matrix multiplication, power of square matrices, matrix trace and transposition.
- Calculate the determinant of a set of vectors, a matrix, and an endomorphism.
- Use determinant calculations to characterize a basis or a property of invertibility.
- Determine the rank of a matrix using extracted determinants and by row echelon form.
- Apply change of basis formulas.
- Solve a linear system using the Gaussian elimination method.
- Understand the concepts of equivalent and similar matrices.
- Master the concepts of inner product and orthogonality.
- Apply the Gram-Schmidt process.
- Perform calculations in orthonormal bases.
- Calculate an orthogonal projection and compute the distance to a subspace.


## b. PI addressed by the course:

| PI | 1.3 |
| :--- | :---: |
| Covered | x |
| Assessed | x |

## 7. Brief list of topics to be covered

- Algebraic structures: groups, rings, fields, symmetric groups (10 hours)
- Vector spaces: definition, linear combination, family of vectors, vector subspaces, affine subspaces, vector space in finite dimension, sum of two vector subspaces, supplementary of a vector subspace ( 10 hours)
- Linear applications: definition, operations, image and kernel, rank, linear forms and hyperplanes, projectors and symmetries ( 10 hours)
- Matrices: matrix calculation (operations, transpose, trace), matrix of a linear application, group of invertible matrices, elementary operations, change of bases (10 hours)
- Determinants: alternating multilinear forms, determinant of a family of vectors in a basis, determinant of a square matrix, determinant of an endomorphism (10 hours)
- Linear systems: definition, resolution, Cramer system (10 hours)
- Euclidean spaces: scalar product, associated norm, orthogonality, coordinates in an orthonormal basis, orthogonal of a part, orthogonal supplementary of a finite dimensional vector subspace, distance to a vector subspace, vector isometries, orthogonal matrices (10 hours)

