Algebra 1

1. **Course number and name:** 020AL1CI2 Algebra 1

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 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)