ALGEBRA

Course Syllabus

1. General Information

Course name: Algebra

Course code: BAS1201

Number of credits: 3

2. Objectives

Algebra provides students with the techniques and methods of linear algebra as follows:

- ***Knowledge:***
    - Formal logic;
    - Modern mathematical languages: The set theory, mappings;
    - Boolean algebra;
    - Methods of linear algebra.
- ***Skills:***
    - Critical and analytical thinking;
    - Computational skills of linear algebra: Determinants, matrix operations, solving systems of linear equations, diagonalization of matrices, Gram-Schmidt process,…
    - Using algebraic tools to study specific problems.
- ***Attitude:***
    - Prepare lessons before class and pay attention to lectures;
    - Doing homework, midterm tests, assignments.

3. Abstract

- Provide students with the mathematical logic and help students to get critical and analytical thinking;
- Overview of Boolean algebra, a structure is used in Electronics and Telecommunications and Information technology;
- Provide students with methods of linear algebra: Vector spaces, matrices, determinant, systems of linear equations, linear transformations, scalar products, Euclidean spaces and quadratic forms. They help learners to solve problems of linear models in Electronics and Telecommunications and Information technology.

4. Teaching and learning methods

Lectures: 36h

Project & practice: 8h

Self-study: 1h

5. Prerequisites

Elementary mathematics, high school algebra.

6. Learning Outcomes

On successful completion of the course, students will be able to:

1. Understand the basic terms in Boolean and linear algebra;

2. Use algebraic tools to solve problems;

3. Apply methods of linear algebra to problems of linear models in Electronics and Telecommunications and Information Technology.

7. Assessment Criteria

Learning outcomes **On successful completion of the course, a learner will**	**Assessment criteria for pass**
LO1: Understand the basic terms in Boolean and linear algebra	- Boolean algebra - Switching circuit design - Vector spaces, matrix operations, determinants, systems of linear equations - Euclidean spaces, Gram-Schmidt process, quadratic forms
LO2: Use algebraic tools to solve problems	- Solve problems of switching circuits - Solve problems by systems of linear equations
LO3: Apply methods of linear algebra to problems of linear models in Electronics and Telecommunications and Information technology	- Analyse problems - Analyse mathematical models - Analyse linear models - Critical and analytical thinking - Solving problems

8. Outlines

Chapter 1: Survey on propositional logic, sets, mappings and Boolean algebra

1.1 Propositional logic

1.1.1 Notion of proposition

1.1.2 Logical connectives

1.2 Sets

1.2.1 Notion of set, descriptions. Sets of numbers

1.2.2 Subsets. Operations of sets

1.2.3 Universal quantifier, existential quantifier. Extended union and intersection

1.2.4 Cartesian product

1.3 Mappings

1.3.1 Definition of mapping, classification of mappings

1.3.2 Inverse mappings. Composition of mappings

1.4 Boolean algebra and applications

1.4.1 Definition and basic properties of Boolean algebra

1.4.2 Boolean formulas, Boolean functions and duality principle

1.4.3 Methods generating Boolean functions with given values

1.4.4 Applications of Boolean algebras to switching circuits

Chapter 2: Vector spaces

2.1 Introduction to vector spaces

2.2 Subspace

2.2.1 Definition, examples, properties

2.2.2 Subspace spanned by a set of vectors

2.2.3 Sum of subspaces. Direct sum

2.3 Linear dependence, linear independence

2.4 Maximal linearly independent set of vectors. Rank of a set of vectors

2.5 Basis and dimension of a vector space. Coordinates of a vector

Chapter 3: Matrices and determinants

3.1 Matrices

3.2 Matrix operations

3.2.1 Sum of matrices

3.2.2 Scalar multiplication

3.2.3 Matrix multiplication

3.2.4 Matrix polynomials

3.2.5 Transpose of a matrix

3.3 Matrix of a set of vectors

3.3.1 Matrix of a set of vectors in a given basis

3.3.2 Change of basis matrix

3.3.3 Change of coordinates

3.4 Rank of a matrix

3.4.1 Definition and computation of rank of a matrix by elimination

3.4.2 Matrices correspond to eliminations

3.5 Definition of determinant

3.6 Computation of determinants

3.7 Applications of determinant

Chapter 4: Systems of linear equations

4.1 Systems of linear equations

4.1.1 General form

4.1.2 Matrix form

4.1.3 Vector form

4.2 Theorem of existence of solutions

4.3 Some methods of solving linear systems

4.3.1 Cramer's method

4.3.2 Inverse matrix method

4.3.3 Gaussian elimination

4.4 Homogeneous linear systems

4.4.1 Set of solutions of homogeneous linear systems

4.4.2 The relation between the set of solutions of general linear system and respective homogeneous linear system

Chapter 5: Linear transformations

5.1 Notion and properties of linear transformations

5.2 Kernel and image of a linear transformation. Rank of linear transfomations

5.3 Surjective, injective and isomorphism

5.4 Matrix of linear transformation

5.5 Coordinates formula of linear transformation. The relation between linear transformation and linear system

5.6 Diagonalization

5.6.1 Eigenvalues. Eigenvectors. Eigenspaces

5.6.2 Characteristic polynomials

5.6.3 Diagonalizable condition of endomorphisms and matrices

5.6.4 Diagonalization algorithm

Chapter 6: Quadratic forms. Euclidean spaces

6.1 Bilinear forms

6.1.1 Definition of bilinear forms

6.1.2 Matrix and coordinates of a bilinear form

6.1.3 Coordinates of the bilinear form in other basis

6.2 Quadratic forms

6.2.1 Definition of quadratic form. Polar form of the quadratic form

6.2.2 Matrix and coordinates of a quadratic form

6.2.3 Expression of coordinates of cannonical forms of a quadratic form

6.2.4 Lagrange's method

6.2.5 Jacobi's method

6.2.6 Sylvester's law of inertia

6.3 Inner product. Euclidean space

6.3.1 Definition of inner product and properties

6.3.2 Orthogonal. Gram-Schmidt

6.3.3 Orthonormal basis

6.4 Orthogonal matrices. Orthogonal diagonalization matrices

6.4.1 Orthogonal matrices

6.4.2 Orthogonal diagonalization algorithm

6.4.3 Change coordinates of quadratic forms to cannonical forms by orthogonal diagonalization

9. Required Textbooks

1. L. B. Long, *Algebra*, Information and Telecommunications Publishing House, 2008 (Vietnamese).

2. D. P. Nga, *Lectures on Algebra*, Posts and Telecommunications Institute of Technology, 2010.

10. Suggested Textbooks

1. N. D. Tri et al., *Advanced Mathematics,* Vol. 1, Vietnam Education Publishing House, 1996.

2. J. P. Monier, *Algebra,* Vol. 1 and 2, Vietnam Education Publishing House, 2000.

3. S. Lipschutz, M. Lipson, *Theory and problems of Linear Algebra*, Schaum's Outline Series, Mc Graw-Hill, 2009.

4. D. Lay, *Linear algebra and Its applications*, Addison-Wesley, 2012.

5. G. Strang, *Introduction to linear algebra*, Wellesley-Cambridge Press, 2009.

11. Grading Policy

Attendance:	10%
Average of mini midterm tests:	10%
Assignments:	10%
Final exam:	70%

Lecturer **Head of Department of Mathematics**

Assoc. Prof. Dr. Le Ba Long **Assoc. Prof. Dr. Pham Ngoc Anh**