NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF INDUSTRIAL AND SYSTEMS ENGINEERING

SYSTEMS ENGINEERING PROGRAM

CB111 – LINEAR ALGEBRA

I. GENERAL INFORMATION

CODE	: CB111 Linear Algebra
SEMESTER	: 2
CREDITS	: 3
HOURS PER WEEK	: 4 (Theory - Practice)
PREREQUIREMENTS	: CB101 Analytical Geometry
CONDITION	: Mandatory

II. COURSE DESCRIPTION

The course is theoretical and practical and has the purpose of providing students of the College of Mechanical Engineering with concepts of vector, matrices, transformations and Boolean algebra.

III. COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Model electric and digital schemes with basic control systems, applying the concepts of the Boolean algebra.
2. Solve problems with real context applications, involving matrices, determinates and linear equation systems.
3. Analyze the existence of vector spaces and subspaces and the relationship between them with definitions and axioms. Definitions that involve linear transforms and generalization of subspaces of eigenvectors.
4. Determinate a quadratic and bilinear form, and the representation of the diagonalized form, and, for the particular case of R^3, the graphic form.

IV. LEARNING UNITS

1. BOOLEAN ALGEBRA / 12 HOURS

Definition of Boolean algebra. Boolean theorems. Schematic representation of logic operations. Boolean functions. Normal forms. Logic circuits. Algebraic description of a logic circuit. Max and min terms. Evaluation of the output of a logic circuit.

2. **MATRICES, DETERMINANTS AND LINEAR EQUATION SYSTEMS / 18 HOURS**
   Definition of matrix. Basic operations. Canonic matrix. Range of a matrix. Determinants. Properties of the determinant of a matrix. Methods to calculate the determinant of a matrix. Vandermonde's determinant. Mins and cofactors of a matrix. Adjugated matrix and its properties. Inverse matrix and its properties. Calculation of the inverse matrix by basic operations. Linear equation systems. Solutions of a linear equation system. Consistent and inconsistent linear equation systems. Applications. Inter-industry matrix. Markov's matrix.

3. **ANALYTIC GEOMETRY IN THREE-DIMENSION SPACE / 12 HOURS**
   Three-dimension coordinate system. Rectangular coordinate system. Vectors in three-dimension space. Operations with vectors. Cross and dot product. Norm of a vector. Orthogonal projection. Component of a vector. Angle between vectors. Geometric meaning of the cross product. Applications of the cross product. Equation of a line: vector, parametric and symmetric form. Division of a line given a proportion. Parallel and orthogonal lines. Angle between lines. Minimum distance between two lines.

4. **VECTOR SPACES / 12 HOURS**
   Definition of a vector space. Properties. Linear dependence of vectors. Bases and dimension of a vector space. Bases of a subspace. Generation conjunct. Addition of subspaces.

5. **LINEAR TRANSFORMATIONS / 12 HOURS**
   Definition. Algebra of linear transformations. Kernel and image of a linear transformation. Matrix representation of a linear transformation. Range and nullity of matrices. Transformation matrix. Dimension of the image and kernel of the transformation. Internal product.

6. **DIAGONALIZABLE MATRICES, QUADRATIC AND BILINEAR FORMS / 18 HOURS**
   Eigenvalues and eigenvectors of a linear transformation. Cayley-Hamilton theorem. Gram-Schmidt orthogonalizing procedure. Similar and diagonalizable matrices. Symmetric and diagonalizable matrices. Bilinear forms. Quadratic forms. Matrix of a bilinear form. Surface identifying using bilinear forms. Quadratic surfaces: sphere, cone and cylinder.

V. METHODOLOGY

The course will be composed by two major activities:

A. Exposition
The professor will expose the concepts and review problems, with the purpose of teaching the students the concepts, theorems and apply them on engineering. Multimedia resources will be used, along with offprints and referential bibliography.

B. Investigation teamwork
It will reinforce the concepts to the students, and improve their social skills.

The students will interact with a virtual platform (Moodle). There will be available many resources to help students understand the concepts and practice with exercises.

VI. GRADING FORMULA

The course will be evaluated according to the "F".

The final grade (NF):

N.F. = (1P.P. + 1E.P. + 2 E.F.) / 4

Average of quizzes (P.P.)

Midterm exam (E.P.)

Final exam (E.F.)

Examination of rectification (ES) is optional.

Number of quizzes: 04 four and the average of quizzes (P.P.) is the arithmetic average of the 03 highest marks of the quizzes.

VII. BIBLIOGRAPHY

1. **KOLMAN, B and HILL, D.** (2006) *Linear algebra*. 8th edition. Pearson Education. Mexico.
2. **GROSSMAN, S**. (2007) *Linear algebra*. McGraw Hill. Mexico.
3. **FRALEIGH, B**. (1989) *Linear Algebra.* Addison-Wesley Iberoamericana. Mexico.
4. **MORRIS, M**. (1991) *Computing engineering and Hardware Design.*
5. **MORRIS, M**. (1985) *Digital logic and computer design.*