NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES
COMPUTER SCIENCE PROGRAM

CM142 – VECTOR CALCULUS II

I. GENERAL INFORMATION

CODE	**:**	CM142 Vector Calculus II
SEMESTER	**:**	2
CREDITS	**:**	5
HOURS PER WEEK	**:**	6 (Theory – Practice)
CONDITION	**:**	Compulsory
PREREQUISTES	**:**	CM141 Vector Calculus I

II. COURSE DESCRIPTION

The course prepares students in the understanding and application of matrices and determinants to solve diverse mathematics and engineering problems. Matrix eigenvalues and eigenvectors are calculated and interpreted, as well as linear transformation in 2-D and 3-D are analyzed and computed. Quadratic forms are studied and their different forms are analyzed.

III. COURSE OUTCOMES

1. Analyze the properties of matrices and complete matrix operations including determinant and inverse.
2. Build mathematical models of matrices and system of linear equations to solve practical mining engineering problems.
3. Understand the concept and properties of linear transformation.
4. Calculate and interpret the eigenvalues and eigenvector of a matrix.
5. Represent matrices in diagonal and other canonical forms.
6. Solve and apply quadratic forms.

IV. COURSE CONTENTS

1. MATRICES AND DETERMINANTS

Matrix. Elements. Rows and columns / Order / Types of matrices. Square, null, triangular, diagonal, identity, nilpotent and periodic matrices / Equality of matrices / Operations with matrices. Addition, Multiplication of a scalar by a matrix. Product of matrices / Transpose of a matrix / Symmetric and antisymmetric matrices / Properties of determinants / Non-singular matrix / Inverse matrix / Minors and cofactors of a matrix / Adjoint matrix / Inverse matrix by the method of the adjoint / Determination of the cofactors of a matrix of order 4 / Generalization to matrices of order n / Step matrix / Calculation of the range of a matrix / Calculation of the inverse of a matrix by sequential basic operations / Solution of linear equation systems by matrix methods: Cramer's law, elementary operations.

2. VECTOR SPACES

N-dimensional Euclidean spaces / Operations: sum, multiplication by a scalar / Vector length / Linear combination / Sub-space generation / Linear independence / Base and dimension / Matrix column space and row space / Method for finding bases / Spaces with internal product /

Cauchy-Schwartz inequality / Angle between vectors / Orthonormal bases / Gram-Schmidt process / Base change / Rotation of coordinate axis in plane and space / Orthogonal matrix.

3. LINEAR TRANSFORMATIONS

Definition / Types of linear transformations: identity, dilation, contraction, rotation / Projection / Core and image / Linear transformations $R^n x R^n$ and $R^n x R^m$ / Geometry of linear transformation in R^2. Associated matrices in linear transformations / Equivalence / Similarity.

4. EIGENVALUES AND EIGENVECTORS

Eigenvalue and eigenvector / Characteristic polynomial / Properties / Matrix diagonalization / Necessary and sufficient conditions for diagonalization / Orthogonal diagonalization / Simetric matrix / Quadratic forms / Application to conic sections on plane and in space.

5. QUADRATIC FORMS

Homogeneous coordinates in space / Parametric equation of a line passing by two points / Quadratic forms / General equation / Degenerate quadratic forms / Tangent plane to a quadratic form / Quadratic canonic form / Sphere surface / Revolution ellipsoid / Hyperboloid / Paraboloids / Intersection of plane quadratics / Quadratic classification.

V. METHODOLOGY

The course takes place in theory and practice sessions. In theory sessions, the instructor presents the concepts, theorems and applications. In practice sessions, different kinds of problems are solved and the solutions are analyzed. Active participation of students is encouraged in all sessions.

VI. GRADING SYSTEM

The Final Grade (PF) is calculated with the following formula:

PF = (EP + EF + PP) / 3

ME: Mid-term exam EF: Final Exam
PP: Average of quizzes

VII. BIBLIOGRAPHY

1. **J. DE BURGOSS**
   Linear Algebra
   Mc Graw Hill, Ed., 2012, Mexico
2. **HASSER, LASALLE, SULLIVAN**
   Mathematic Analysis
   Trillas Edition, 2000, Mexico
3. **ANTON HOWARD**
   Introduction to Linear Algebra
   Limusa-Wiley Editions. 2010
4. **GRANERO RODRIGIEZ**
   Algebra and Analytic Geometry
   Mc Graw Hill, Ed., 2010, Mexico