



# NATIONAL UNIVERSITY OF ENGINEERING

## COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

### MINING ENGINEERING PROGRAM

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#### BMA03 – LINEAR ALGEBRA

##### I. GENERAL INFORMATION

<b>CODE</b>	: BMA03 Linear Algebra
<b>SEMESTER</b>	: 2
<b>CREDITS</b>	: 4
<b>HOURS PER WEEK</b>	: 5 (Theory–Practice)
<b>PREREQUISITES</b>	: -
<b>CONDITION</b>	: Compulsory

##### II. COURSE DESCRIPTION

The course prepares students for the analysis sequences and series and determining their properties and convergence. Students also complete operations with complex numbers and find the real and complex roots of a given polynomial, compute and interpret the eigenvalues and eigenvector of matrices, and construct the quadratic form of real functions. The course provides students with the principles of series, complex number and matrix transformations to be applied to solve engineering problems.

##### III. COURSE OUTCOMES

At the end of the course, students:

1. Analyze the properties of sequences and series determining their convergence and properties.
2. Carry out operations with complex numbers in different representations.
3. Find the roots of a polynomial using exact or numeric methods.
4. Calculate and interpret the eigenvalues and eigenvectors of a matrix.
5. Construct matrix representation of functions.

##### IV. LEARNING UNITS

###### 1. SEQUENCES IN R

Real sequences / Limit of a sequence / Notable limits / Convergence theorems / Divergent sequences / Increasing and decreasing sequences / Bounded sequences.

###### 2. SERIES IN R

Real series / Convergence and divergence of series / Notable series. Geometric series / Series properties / Addition of series / Convergence criteria / Absolute convergence / Power series / Convergence (divergence) of power series / Convergence radius / Differentiation and integration of series.

###### 3. COMPLEX NUMBER AND POLYNOMIAL ROOTS

System of complex numbers / Real part and imaginary part / Magnitude and angle of complex numbers / Polar form / Exponential form / Operation with complex numbers / Moivre formula / Roots of a complex numbers / Root of grade 3 polynomials / Roots of a polynomial / Algebra fundamental theorem / Solution of polynomial equations / Synthetic division method / Numeric method: Newton method bisection method / Interpolation / Lagrange formula.

#### **4. EIGENVALUES AND EIGENVECTORS**

Linear transformations / Translation. Rotation. Dilation. Contraction / Nonsingular transformations / Characteristic polynomial of a matrix / Eigenvalues of a matrix / Eigenvectors of a matrix / Matrix diagonalization. Necessary conditions / Orthogonal matrix / Gram Schmidt process.

#### **5. QUADRATIC FORMS**

Matrix representation of a quadratic form / Diagonalization of quadratic forms / Identification of conic sections / Identification of quadratic surfaces.

#### **6. VECTOR SPACES**

Vector spaces / Core / Image / Matrix representation of linear transformations.

### **V. PRACTICAL EXPERIENCES**

Session 1: Sequences and series

Session 2: Complex numbers and polynomial roots

Session 3: Eigenvalues and eigenvectors

Session 4: Quadratic forms

Session 5: Vector spaces

### **VI. METHODOLOGY**

The course takes place in theory and practice sessions. In theory sessions, faculty presents the concepts, methods and principles. In practice sessions, students, under the guidance of faculty, solve diverse problems on series, complex numbers, eigenvalues and eigenvector, quadratic forms. Student active participation is promoted.

### **VII. GRADING FORMULA**

The Final Grade PF is calculated as follow:

$$PF = (EP + EF + PP) / 3$$

EP: Mid-Term Exam

EF: Final Exam

PP: Average of 4 Practical Works

### **VIII. BIBLIOGRAPHY**

1. KOLMAN, BERNARD.  
Linear Algebra, Pearson Ed., 2016
2. GORDON FULLER, DALTON TARWATER.  
Analytic Geometry, Pearson Ed., 2015