Bachelor program,
Instrumentation Engineering (INEN) program, "General and Applied Mathematics" department

Course Unit Title	**Linear Algebra and Analytical geometry**
Course Unit Code	VTSS-B01
Type of Course Unit	Compulsory
Level of Course Unit	1 st year INEN program
National Credits	0
Number of ECTS Credits Allocated	4
Theoretical (hour/week)	2
Practice (hour/week)	2
Laboratory (hour/week)	0
Year of Study	1
Semester when the course unit is delivered	1
Course Coordinator	Ruqiyya Azizova
Name of Lecturer (s)	Ruqiyya Azizova
Name of Assistant (s)	-
Mode of Delivery	Face to Face
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	-

Course description:

This course introduces the fundamental concepts of linear algebra and analytical geometry, including vector spaces, matrices, determinants, systems of linear equations, eigenvalues and eigenvectors. It also covers the geometric interpretation of these concepts in two- and three-dimensional spaces, focusing on lines, planes, conic sections, and transformations. Practical applications in science and engineering are emphasized to develop problem-solving skills.

Objectives of the Course:

After successful completion of the course students will be able to understand the concepts of vectors, matrices, and vector spaces, solve systems of linear equations using matrix methods, analyze eigenvalues and eigenvectors and their applications, interpret geometric objects such as lines, planes, and conic sections in space, apply linear transformations and analytical geometry concepts to real-world problems.

Learning Outcomes

At the end of the course the student will be able to		Assessment
1.	Perform the operations of addition, multiplication and find the inverse and transposes of vectors and matrices.	1,2,3
2.	Solve systems of linear equations using Gaussian elimination	1,2,3
3.	Define and identify linear dependence and independence of a collection of vectors.	1,2,3
4.	Calculate determinants using row operations, column operations, and expansion down any column or across any row.	1,2,3
5.	Calculate eigenvalues, eigenvectors and eigenspaces.	1,2,3
6.	Determine if a matrix is diagonalisable, and if it is, diagonalise it.	1,2,3
7.	Solve systems of dynamic linear equations using eigenvalues.	1,2,3

Assessment Methods: 1: Final Exam, 2: Midterm exam, 3: Individual work, 4: Seminar

Course's Contribution to Program

		CL
1	Ability to develop as a specialist in the field of fundamental sciences and apply basic knowledge.	3
2	Ability to analyze and model functional and structural schemes of various purpose devices and systems.	4
3	Ability to use modern methods and tools, creation, selection, and application of engineering and information technology tools and modern devices and equipment.	4
4	The ability to use the strategy of team cooperation in the exchange of information, knowledge, and experience to achieve the set goal.	3
5	As a result of training, the ability to use engineering knowledge, mathematical models, and basic concepts of physics and chemistry in production and technological processes,	4

	automation, measurement, and control systems.	
6	The ability to use modern software to process technical documents of devices, design their structures, and algorithmize processes.	3
7	The ability to apply artificial intelligence to improve the quality characteristics of measurement and control systems.	4
8	The ability to process information acquisition, processing, and transmission processes based on schematic and programmable logical integrated circuits.	4
9	Ability to use knowledge to improve quality indicators and environmental safety of production processes.	4
10	Self-development ability to apply theoretical and experimental knowledge in solving modern engineering problems.	4
CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)		

Course Contents

Week	Chapter	Topics	Exam
1	[7], Ch 8	**Complex numbers.** Concept of complex numbers. Operations on complex numbers. Argument and absolute value of complex number. Trigonometric form of complex numbers. Euler formula. The power of a complex number and root from a complex number.	
2	[1], Ch 2, pp.40-62	**Matrixces and determinants** Definition of a Matrix. Operations on matrices. Definition of determinants, properties and finding determinants. Minors and cofactors of the determinant.	
3	[1], Ch 2, pp.62-72	**Definition of Inverse Matrix.** Necessary and sufficient condition for existence of an inverse matrix. Methods for finding the inverse matrix. The rank of the matrix and methods of its finding. Basis minor and theorem about basis minor	
4	[1], Ch 1, pp.2-13	**Systems of linear algebraic equations.** Basic concepts of the systems of linear algebraic equations. System of homogeneous and nonhomogeneous linear algebraic equations. System of consistent and inconsistent linear algebraic equations. Matrix representation of a system of linear algebraic equations. Kronecker-Capelli theorem.	
5	[1], Ch 1, pp.13-25	**Methods for solving systems of linear algebraic equations.** Solution of a system of linear algebraic equations by the Cramer's rule and Gauss methods. Solution of a system of homogeneous linear algebraic eqautions.	
6	[1], Ch 6, pp.292-324	**Linear transformations.** Definition, basis and dimension of linear space. Euclidean space. The concept of linear transformations. The matrix of a linear transformation. Operations on linear transformations. Change of the linear transformation matrix when the basis changed. Eigenvalues and eigenvectors of a linear transformations.	
7	[8], Ch 10, pp.605-610	**Quadratic forms.** Definition of quadratic forms. Canonical representation of a two-variable quadratic form. Sylvester's criterion.	
8			Midterm
9	[8], Ch 10	**Coordinat system.** Rectangular and Cartesian coordinate system on a plane. Rectangular and Cartesian coordinat system in space. Polar coordinate system	
10	[8], Ch 10, pp.568-583	**Vectors algebra.** Scalar and vector quantities. Linear operations on vectors. Linear dependence of vectors. Basis vectors. Separation of vectors on the basis. Scalar product, vector product and its properties. Mixed product of three vectors and its properties. Area and volume calculation.	
11	[8], Ch 10, pp.585-590	**Straight line equations on a plane.** The general, parametric, the slope, normal and intercept forms of the equation of a straight line. The angle between two straight lines, the distance from a point to a straight line, the equation of a straight line passing through two points.	

12	[8], Ch 10	**Plane equations.** The general, normal and intercept forms of the equation of plane. Plane equation passing through three points. The angle between two planes. Distance from a point to plane. Mutual position of two planes.	
13	[7], Ch 2, pp.96-105	**Second-order curves.** Definition of an ellipse, derivation of canonical equation, eccentricity, directrix. Definition of hyperbola, derivation of the canonical equation, eccentricity, directrix and asymptotes. Definition of parabola, canonical equation.	
14	[7], Ch 2, pp.314-326	**Investigation of the general equation of second-order curves.** General equation of second-order curves and determination of their type. Invariants of a second-order curves. Canonical representation of the general equation of second-order curves.	
15	[7], Ch 2	**Surface and its equation.** Canonical equations of second-order surfaces. Cylindrical surfaces (elliptical cylinder, hyperbolic cylinder, parabolic cylinder). Rotating surfaces (rotating ellipsoids, hyperboloids and paraboloids and rotating cones). Ellisoid, unipolar hyperboloid, bipolar hyperboloid, cone, elliptical paraboloid, hyperbolic paraboloid	
16			Final exam

Recommended Sources

TEXTBOOK(S)

1. Ron Larson, Elementary Linear Algebra, eighth edition.
2. Hiroyuki Shima. Tsuneyoshi Nakayama. Higher Mathematics for Physics and Engineering. Berlin 2010.
3. Otto Bretscher, Linear algebra with applications, fifth edition.
4. Michael Corral. Vector Calculus. Schoolcraft college.2008.
5. Sheldon Axler. Linear Algebra Done Right. New York.1997.
6. Donald Allen.Lectures on Linear Algebra and Matrices. Texas A and M University 2003.
7. A.D.Myshkis. Introductory Mathematics for Engineers.Moskow.1972.
8. Robert. A. Adams Calculus. A Complete Course. Pearson Canada, Toronto.2014

Assessment

Attendance	0%	Less than 75% class attendance results in NA grade
Individual work	20%	
Lab. works	0%	
Course work	0%	
Quiz	10%	
Midterm Exam	20%	Written Exam
Final Exam	50%	Written Exam
Total	100%	

Assessment Criteria

Final grades are determined according to the Academic Regulations of Azerbaijan State Oil and İndustry University for undergraduate studies

Course Policies

1. Attendance of the course is mandatory.
2. Material presented in the lecture as well as assigned readings will be included in testing.
3. Late assignments will not be accepted unless an agreement is reached with the lecturer.
4. Cheating and plagiarism will not be tolerated.
5. Cheating will be penalized according to the Azerbaijan State Oil and Industrial University General Student Discipline Regulations

ECTS allocated based on Student Workload

Activities	Number	Duration (hour)	Total Workload (hour)
Course duration in class	14	4	56
Individual work	9	4	36
Self-study	10	1	10
Tutorials	3	4	12
Midterm Examination	1	3	3
Preparation for midterm exam	1	15	15
Final Examination	1	3	3
Preparation for final exam	1	12	12

Total Workload	147
Total Workload/30(h)	4.9
ECTS Credit of the Course	4