International Information Technology University JSC
Faculty of Information Technology
Department of Mathematical and Computer Modeling

Approved
Vice-Rector of Academic and
Educational Affairs of IITU JSC, PhD
_____ Umarov T.F.
«__» ____ 2020

# SYLLABUS
# (ACADEMIC PROGRAM)

**Course:** AG 1207 Algebra and Geometry

**Major**: 6B061 Information and communication technology

**Educational program:** 6B06101 Computer science

**Year**: 1; **Semester:** 1 **Number of credits**: 4 ECTS

**Lectures:** 15 hours

**Practical classes:** 30 hours

**T/SIS:** 75 hours

**Total:** 120 hours

**Final assessment form**: Examination

Almaty 2020

Academic program of the course «AG 1207 Algebra and Geometry» has been reviewed at the meeting of Mathematical and Computer Modeling department.

Minutes №. 1 dated «17» August 2020

Head of the Department _____ Ydyrys A., assistant – professor PhD
signature full name, title, degree

Author _____ Nessipbayev Y.K., senior-lecturer
signature full name, title, degree

The working academic program was approved at the meeting of the Educational and Methodological Board of JSC "IITU"

Minutes № 1 dated " 28" August 2020 .

Director of the Department _____ A.Mustafina
Signature

for Academic Affairs

| 1. GENERAL INFORMATION | |
|---|---|
| Faculty | Information Technology |
| Major code and title | 6B061 Information and communication technology |
| Educational program code and title | 6B06101 Computer science |
| Year, semester | 1st year, 1st semester |
| Subject category | Compulsory |
| Number of credits (ECTS) | 4 |
| Prerequisites | None |
| Postrequisites | None |
| Lecturer | Nessipbayev Yerlan Khabdulkhanovich, Master of Science in Mathematics, senior-lecturer, y.nessipbayev@iitu.kz |

## 2. GOALS, OBJECTIVES AND LEARNING OUTCOMES OF THE COURSE

**The course goal is**

The goals of the course are to familiarize students with the important branches of analytic geometry and their applications in computer sciences. During the educational process, students should become familiar with and able to apply geometrical tools to solve a variety of applied problems in topics such as vector algebra, affine and rectangular coordinates, line in plane, plane and line in space, curves and surfaces of the second order, affine transformations of plane and others.

Linear algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices. The concepts of linear algebra are extremely useful in physics, economics and social sciences, natural sciences, and engineering. This course provides students with the knowledge of fundamental of linear algebra and the theory of matrices. On completion of this course the student will master the basic concepts and acquires skills in solving problems in linear algebra.

**The objectives of the course are**

- geometrical skills;
- skills to process and evaluate effectively both theoretical and real-life quantitative data;
- skills to apply the main methods of problem solving to the situations connected with the major.

**Learning outcomes of the course**

- Know basic notions of analytic geometry;
- Be able to demonstrate mastery of mathematical concepts, analysis and techniques to the advanced level;
- apply matrix operations, calculate determinants, inverse matrices, rank of a matrix
- solve systems of linear algebraic equations using Cramer's rule, inverse matrix method, and Jordan-Gauss method
- investigate solvability of a system using Kronecker-Capelli theorem
- explain the defining properties of a vector space, construct examples of vector spaces, explain why a set defined with the necessary operations is or is not a vector space
- explain why a subset of a given vector space is or is not a subspace
- define the span of a set of vector, determine if a collection of vectors from a given vector space is a spanning set for the vector space
- define linear independence, calculate whether or not a given set of vectors is linearly independent.
- Understand and create mathematical arguments; use computer technologies and techniques;
- Be able to think clearly, sequentially and logically, as required for critical analysis of mathematical problems;
- Be qualified in processing and evaluating effectively both theoretical and real-life quantitative data;

## 3. Course description

This course includes the study of matrix algebra, determinants, systems of linear equations, vector algebra, analytic geometry on plane and on space, lines and planes, second order curves

## 4. COURSE POLICY

**Students are forbidden to:**

- submit any tasks after the deadline. The mark for late submissions is decreased;
- cheat. Plagiarized papers shall not be graded;
- be late for classes. Three times' tardy amounts to one absence;
- retake any tests, unless there is a valid reason for missing them;
- use mobile phones in class/Microsoft Teams/Zoom.

**Students should always**

- be appropriately dressed (formal/semi- formal styles are acceptable);
- show consideration for and mutual support of teachers and other students;
- let the teacher know of any problems arising in connection with English studies.

**Online classes** will be on platforms MS Teams, Dl and Zoom.

## 5. LITERATURE

**Basic literature:**


1. Anton, H. Elementary Linear Algebra / Howard Anton.- 11 изд.- USA: Wiley, 2014.- 802 p.
2. Stephen Andrilli and David Hecker, Elementary Linear Algebra, Fifth edition, 2016, Elsevier, ISBN 978-0-12-800583-9.
3. Konev V.V., Linear algebra, vector algebra and analytical geometry
4. Lungu K.N., Pismennyi D.T., Fedin S.N., Shevchenko Y.A., Problems manual in higher mathematics, 1 year.
5. Beklemishev D.V., Course of analytic geometry and linear algebra. – Moscow: PHIZMATLIT, 2009, 312 pages.
6. Beklemisheva L.A., Beklemishev D.V., Petrovich A.Yu., Chubarov I.A., The collection of problems on analytic geometry and linear algebra. – SPb.: Lan, 2008, 496 pages.
7. https://www.youtube.com/watch?v=ZK3O402wf1c&list=PL49CF3715CB9EF31D&index=1


**Supplementary literature:**


1. Bugrov Ya.S., Nikolskiy S.M., Higher mathematics. Elements of linear algebra and analytic geometry, the sixth issue, Moscow: Dropha, 2004.
2. Danko P.E., Popov A.G., Kozhevnikova T.Ya., Higher mathematics in exercises and problems. The fifth issue, revised. – Moscow: «Higher school», 1999, parts 1 and 2.
3. Golovina L.I., Linear algebra and some its applications. – Moscow: Nauka, 1975, 408 p.
4. S. Lipschutz, Theory and problems of linear algebra, Schaum's outline series, 1987.
5. Grigoriev S.G., Linear algebra. – Moscow: Information center "Marketing", 1999.


## 6. Course schedule

| | Abbreviation | Meaning |
|---|---|---|
| | TSIS | Teacher-supervised independent work (СРСП) |
| | SIS | Students' independent work (СРС) |
| | IHW | Individual home work |

| Week No | Course Topic | Reference Materials | Lectures (2 h/w) | Practice sessions | TSIS (1 h/w) | SIS (4 h/w) |
|---|---|---|---|---|---|---|
| 1 | Complex numbers and operations on them. The modulus and argument of a complex number. Algebraic and trigonometric forms of a complex number. Exponential form of a complex number. | 1-2, Ch. 1 | 1 | 2 | 1 | 4 |
| 2 | Euler's formula. Roots from complex numbers. Polynomials. The fundamental theorem of algebra. | 1-2, Ch. 2 | 1 | 2 | 1 | 4 |
| 3 | Matrices: Basic definitions, matrix operations | 1-2, Ch. 3 | 1 | 2 | 1 | 4 |
| 4 | Determinants, properties of matrix operations, properties of determinants | 1-2, Ch. 3 | 1 | 2 | 1 | 4 |
| 5 | Inverse matrices, calculation of inverse matrices | 1-2, Ch. 4 | 1 | 2 | 1 | 4 |
| 6 | Systems of linear algebraic equations (SLAE), matrix rank, basic concepts | 1-2, Ch. 5 | 1 | 2 | 1 | 4 |
| 7 | Gaussian elimination, Cramer’s rule | 1-2, Ch. 5 | 1 | 2 | 1 | 4 |
| 8 | Vector algebra, vectors, basic definitions, geometrical interpretation, resolution of vectors into components | 1-2, Ch. 6 | 1 | 2 | 1 | 4 |
| 9 | Scalar and vector product of vectors, scalar triple product | 1-2, Ch. 6 | 1 | 2 | 1 | 4 |
| 10 | Analytical geometry, straight lines in a plane | 1-2, Ch. 7 | 1 | 2 | 1 | 4 |
| 11 | Angles between two lines, relative positions of lines | 1-2, Ch. 7 | 1 | 2 | 1 | 4 |
| 12 | Planes, general equation of a plane, angle between two planes | 1-2, Ch. 8 | 1 | 2 | 1 | 4 |
| 13 | Angle between a point and a plane, relative position of planes | 1-2, Ch. 8 | 1 | 2 | 1 | 4 |
| 14 | Quadratic curves, circles and ellipses | 2, Ch.5 | 1 | 2 | 1 | 4 |
| 15 | Hyperbolas and parabolas, their properties | 1-2, Ch. 8 | 1 | 2 | 1 | 4 |
| | **Total hours** | **120** | **15** | **30** | **15** | **60** |

## 7. List of topics/assignments for practical classes

| № | Topic Title | Number of hours | References | Form of reporting | Deadline |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Matrices and Determinants | 6 | 1-2 | HW and/or Quiz | TBA |
| 2 | Solving systems of linear equations | 9 | 1-2 | HW and/or Quiz | TBA |
| 3 | Vectors and vector | 9 | 1-2 | HW and/or | TBA |

| | | | | | |
|---|---|---|---|---|---|
| | operations | | | Quiz | |
| 4 | Planes and surfaces | 8 | 1-2 | HW and/or Quiz | TBA |

## 8. List of assignments for Student Independent Study

Proper organization of students independent study is the key to the formation of skills in mastering, learning, assimilation and systematization of acquired knowledge, ensuring a high level of academic performance in the learning process

| № | Topic/Assignment title | Number of hours | References | Form of reporting | Deadline |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | Week 1 |
| 1 | Determinants of matrices. Inverse matrix. | 5 | Basic[1]-[5] Supplementary [1]-[2] | Submission of IHW 1 | Week 2 |
| 2 | Gauss method. | 5 | Basic[1]-[5] Supplementary [1]-[2] | Submission of IHW 2 | Week 3 |
| 3 | Finding area of the triangle and parallelogram. Finding volume of the tetrahedron and parallelepiped. | 5 | Basic[1]-[5] Supplementary [1]-[2] | Submission of IHW 3 | Week 4 |
| 4 | Curves of the first order. Operations over complex numbers. | 5 | Basic[1]-[5] Supplementary [1]-[2] | Submission of IHW 4 | Week 5 |
| 5 | Gauss method.General and particular solutions of SLAE. | 5 | Basic[1]-[5] Supplementary [1]-[2] | Submission of IHW 5 | Week 6 |
| 6 | Vectors, coordinates and operations. Vector products. | 5 | Basic[1]-[5] Supplementary [1]-[2] | Submission of IHW 6 | Week 7 |
| 7 | Linear operations over vectors in coordinate form. Vector coordinates. | 5 | Basic[6]-[7] Supplementary [3]-[8] | Submission of IHW 7 | Week 8 |
| 8 | Operations over vectors. Conic curves. | 5 | Basic[6]-[7] Supplementary [3]-[8] | Submission of IHW 8 | Week 9 |
| 9 | Straight line on the plane. Coordinate Method. General equation of a line and its particular cases. | 5 | Basic[6]-[7] Supplementary [3]-[8] | Submission of IHW 9 | Week 10 |
| 10 | Curves of the second order. Canonical equation of a circle. | 5 | Basic[6]-[7] Supplementary [3]-[8] | Submission of IHW 10 | Week 11 |
| 11 | Curves of the second order. Parabola, its canonical | 5 | Basic[6]-[7] Supplementary [3]-[8] | Submission of IHW 11 | Week 12 |

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|---|---|---|---|---|---|
| | equation and properties. | | | | |
| 12 | Plane, normal vector of a plane. General equation of a plane and its particular cases. | 5 | Basic[6]-[7] Supplementary [3]-[8] | Submission of IHW 12 | Week 13 |

**9. System for evaluating student performance in a discipline:**

Each type of educational work is evaluated on a 100-point scale and is included in the average assessment of the current control, taking into account the weighting coefficient in accordance with the table. Please, discuss the evaluation criteria with a practical class's teacher as it might be very different.

| **Period** | **Assignments** | **Maximum score** | Weighting coefficient | **Total** |
|---|---|---|---|---|
| 1st attestation | HW (1-3) | 100 | 0,2 | **100** |
| | Quiz 1 | 100 | 0,15 | |
| | Quiz 2 | 100 | 0,15 | |
| | Class activity during practical classes. Attending lectures. | 100 | 0,15 | |
| | Midterm | 100 | 0,35 | |
| 2nd attestation | HW (4-7) | 100 | 0,2 | **100** |
| | Quiz 3 | 100 | 0,15 | |
| | Quiz 4 | 100 | 0,15 | |
| | Class activity during practical classes. Attending lectures. | 100 | 0,15 | |
| | Endterm | 100 | 0,35 | |
| **Exam** | | | | **100** |
| Total | **0,3*1stAtt+0,3*2ndAtt+0,4*Ex** | | | **100** |

*If the number of absences exceeds 20%, student will be automatically scheduled for a Retake (summer semester)

**10. Assessment criteria:**

The point-rating letter system for assessing the educational achievements of students with their interpretation in the traditional grading scale:

| Letter Grade | Numerical equivalent | Points (%) | Traditional system assessment | General description of grading criteria |
|---|---|---|---|---|
| A | 4,0 | 95-100 | Excellent | The student has knowledge of the subject in the full scope of the curriculum, understands the discipline deeply enough; shows a high level of knowledge that exceeds the volume |

| | | | | |
|---|---|---|---|---|
| | | | | provided by the syllabus, gives an exhaustive answer |
| A- | 3,67 | 90-94 | | The student has knowledge of the subject in the full scope of the curriculum, understands the discipline deeply enough; gives an exhaustive answer |
| B+ | 3,33 | 85-89 | Good | The student shows a complete, well-founded knowledge of the subject, but the answers did not always highlight the main idea, rational methods of calculation were not always used; the answers were mostly brief and sometimes unclear. |
| B | 3,0 | 80-84 | | |
| B- | 2,67 | 75-79 | | |
| C+ | 2,33 | 70-74 | | |
| C | 2,0 | 65-69 | Satisfactory | The student demonstrates sufficient knowledge of the subject, but without proper depth and justification, the answers are unclear and without proper logical sequence. |
| C- | 1,67 | 60-64 | | |
| D+ | 1,33 | 55-59 | | |
| D | 1,0 | 50-54 | | |
| FX | 0,5 | 25-49 | Unsatisfactory | The student demonstrates insufficient knowledge of the subject, positive answers were not given to individual questions. |
| F | 0 | 0-24 | | The student demonstrates a very low level of knowledge of the subject. |

**11. Assessment and evaluation materials (exam questions)**

– List of exam questions on lecture topics.

1. What is a complex number? Real and Imaginary parts.
2. Operations on complex numbers/
3. The modulus and argument of a complex number.
4. Algebraic, polar (trigonometric) and exponential forms of a complex number.
5. Euler's formula. Roots from complex numbers.
6. The fundamental theorem of algebra.
7. Matrices: Basic definitions, matrix operations.

8. Determinants, properties of determinants.
9. Inverse matrices, calculation of inverse matrices.
10. Systems of linear algebraic equations (SLAE), matrix rank, basic concepts.
11. Gaussian elimination, Cramer's rule.
12. Vector algebra, vectors, basic definitions, geometrical interpretation, resolution of vectors into components.
13. Scalar and vector product of vectors, scalar triple product.
14. Analytical geometry, straight lines in a plane.
15. Angles between two lines, relative positions of lines.
16. Planes, general equation of a plane, angle between two planes.
17. Angle between a point and a plane, relative position of planes.
18. Quadratic curves, circles and ellipses.
19. Hyperbolas and parabolas, their properties.

– Form of assessment (exam): written, oral, comprehensive, design, testing.

Form of final exam: testing.

– Sample exam card with assessment criteria (required).

Assessment criteria: worth of each question is the same.

1. Which of the following is not a linear transformation from 3 to 3?
a. T(x, y, z) = (x, 2y, 3x - y)
b. T(x, y, z) = (x - y, 0, y - z)
c. T(x, y, z) = (0, 0, 0)
d. T(x, y, z) = (1, x, z)
e. T(x, y, z) = (2x, 2y, 5z)
2. Which of the following statements is not true?
a. If A is any n × m matrix, then the transformation T: defined by T(x) = Ax is always a linear transformation.
b. If T: U → V is any linear transformation from U to V then T(xy) = T(x)T(y) for all vectors x and y in U.
c. If T: U → V is any linear transformation from U to V then T(-x) = -T(x) for all vectors x in U.
d. If T: U → V is any linear transformation from U to V then T(0) = 0 in V for 0 in U.
e. If T: U → V is any linear transformation from U to V then T(2x) = 2T(x) for all vectors x in U.
3. If T: U → V is any linear transformation from U to V then
a. the kernel of T is a subspace of U
b. the kernel of T is a subspace of V
c. the range of T is a subspace of U
d. V is always the range of T
e. V is the range of T if, and only if, ket T = {0}

4. If T: U → V is any linear transformation from U to V and B = {u 1, u 2, ..., u n} is a basis for U, then set T(B) = {T(u 1), T(u 2), ... T(u n)}
a. spans V
b. spans U
c. is a basis for V
d. is linearly independent
e. spans the range of T
5. P 3 is a vector space of polynomials in x of degree three or less and Dx(p(x)) = the derivative of p(x) is a transformation from P 3 to P 2.
a. the nullity of Dx is two.
b. The polynomial 2x + 1 is in the kernel of Dx.
c. The polynomial 2x + 1 is in the range of Dx.
d. The kernel of Dx is all those polynomials in P 3 with zero constant term.
e. The rank of Dx is three.
6.Let Ax = b be the matrix representation of a system of equations. The system has a solution if, and only if, b is in the row space of the matrix A.
a. True
b. False
7.If A is an n × n matrix, then the rank of A equals the number of linearly independent row vectors in A.
a. True
b. False

8. For the slope of a line, the change in x is greater than the change in y. Which of the following could represent the slope of this line?

9. Identify the equation that represents the line with a y-intercept of 600 and a slope of 50.

10. Which relation does NOT have an initial vale of 50?

11. How would the graph of the relation y = 3x - 2 change if the 3 and -2 were both doubled? The graph would be:

12. Consider the relation y = -3x + 5. Which of the following statements about the graph of this relation is NOT true?

13. What is the equation of the line that passes through the points (2, 4) and (4, 0)?

14. Janelle draws a line that passes through the points (-1, 6) and (0, 3). If Janelle writes the equation of the line in y = mx + b form, what are the values of m and b?

15. Consider the equation y = mx + 5 . If (7, 3) is a point on the line represented by this equation, which of the following is true?

16. Rearrange 4y - x = 8 so that it is in the form y = mx + b.

17. Which of the following statements is true for the line 5x - 2y - 12 = 0?

18. Mike is asked to graph the linear relation represented by 2x - 3y + 6 = 0. What is the y-intercept of this line?

19. Donna has correctly drawn a line on an xy-plane. Her line is parallel to the line y = - x + 1 and has the same y-intercept as the line y = -2x + 6. Which of the following equations represents the line that Donna has drawn?

20. A line has the following characteristics. It is perpendicular to the line y = 1/2 x + 3 and it passes through the point (4, 0). What are m, the slope, and b, the y-intercept, of the line?

21. Which of the following equations is NOT represented by a straight line on a graph?

22. How many of these equations represent straight lines? y = x - 2; y = 2 - 4x; y = x^2 + 8

23. A local hair charges a $15 entry fee and $1.75 per ride. Dustin has $35 to spend. What is the maximum number of rides Dustin can do on?