



ANALYTICAL GEOMETRY AND LINEAR ALGEBRA

Syllabus

Requisites of the Course

Cycle of Higher Education	<i>First cycle of higher education (Bachelor's degree)</i>
Field of Study	<i>12 Information Technologies</i>
Speciality	<i>123 Computer Engineering</i>
Education Program	<i>System Programming and Specialized Computer Systems</i>
Type of Course	<i>Normative</i>
Mode of Studies	<i>full-time</i>
Year of studies, semester	<i>1 year (1 semester)</i>
ECTS workload	<i>5 credits (ECTS). Time allotment – 150 hours, including 72 hours of classroom work, and 78 hours of self-study.</i>
Testing and assessment	<i>1 semester – Final test, 1 semester – Exam,</i>
Course Schedule	<i>1 classes per week by the timetable http://rozklad.kpi.ua/</i>
Language of Instruction	<i>Ukrainian</i>
Course Instructors	<i>Lecturer: PhD., Associate Professor, Alexandr Neschadym, mobile +380688479206, email om.neshchadym@gmail.com https://classroom.google.com/c/NjYzOTUwMjA5MDQ1</i>

Outline of the Course

1. Course description, goals, objectives, and learning outcomes

The tools of analytic geometry and linear algebra are widely used in all branches of mathematics and its applications. Its role has grown especially with the development of information and computer technologies, which have penetrated practically all spheres of human activity. The educational discipline "Analytic Geometry and Linear Algebra" is an integral part of the basic mathematical training of students majoring in "Computer Engineering" and belongs to the fundamental disciplines. The study of this discipline allows students to develop the competencies necessary for mathematical modeling of processes related to professional activity.

***The purpose** of studying the discipline "Analytic Geometry and Linear Algebra" is to provide students with basic knowledge of the basics of matrix calculus, vector algebra, algebra of operators, analytic geometry on the plane and in space; the ability to solve various problems, to apply the acquired knowledge to solving applied problems.*

***The subject** of the discipline "Analytic Geometry and Linear Algebra" is finite-dimensional linear vector spaces and their mapping by algebraic methods and the study of geometric objects of linear vector spaces by means of algebra and the method of coordinates.*

*As a result of mastering the discipline "Analytic Geometry and Linear Algebra", students must demonstrate the following **learning outcomes**:*

knowledge:

- principles of matrix calculation;*
- methods of calculating determinants;*
- research methods and solving systems of linear algebraic equations;*
- types of lines and surfaces of the first order and their use as mathematical models of applied problems;*
- classification of lines and surfaces of the second order;*
- methods of solving geometry problems using vector algebra methods;*

– linear n -dimensional spaces and linear operators;
– algorithms of orthogonal transformation of quadratic forms, reduction of curves and surfaces of the second order to the canonical form;

skill:

– analyze the condition of the problem, choose the most effective solution method;
– evaluate the obtained results of solving the problem;
– generalize the acquired knowledge to n -dimensional spaces;

experience:

– free operation with abstract mathematical objects and presentation of research results using geometric images;

– development of algorithms for solving complex problems;
– applying knowledge of linear algebra to solving analytical geometry problems.

According to the requirements of the standard of higher education in specialty 123 "Computer Engineering", the study of the discipline "Analytic Geometry and Linear Algebra" contributes to the formation of the following competencies and learning outcomes in students.

General competencies:

GC 1. Ability to abstract thinking, analysis and synthesis.

GC 2. Ability to learn and master modern knowledge.

GC 3. Ability to apply knowledge in practical situations.

GC 7. Ability to identify, pose and solve problems.

Special (professional, subject) competences:

PC 12. Ability to identify, classify and describe the operation of software and technical tools, computer and cyber-physical systems, networks and their components by using analytical methods and modeling methods;

PC 15. Ability to justify the choice of methods for solving specialized problems, critically evaluate the obtained results, justify and defend the decisions made.

PC 16. Ability to algorithmic and logical thinking.

Program learning outcomes:

PLO 6. To be able to apply knowledge to identify, formulate and solve technical problems of the specialty, using methods that are most suitable for achieving the set goals.

PLO 7. To be able to solve problems of analysis and synthesis of means characteristic of the specialty.

PLO 8. To be able to think systematically and apply creative abilities to the formation of new ideas.

PLO 16. To be able to evaluate the obtained results and justify the decisions made.

2. Prerequisites and post-requisites of the course (the place of the course in the scheme of studies in accordance with curriculum)

The discipline "Analytic Geometry and Linear Algebra" is a mandatory component of general training. To successfully master this discipline, it is necessary to have only the skills and knowledge formed by secondary school.

The theoretical knowledge and practical skills obtained during the mastering of the discipline "Analytical Geometry and Linear Algebra" are necessary for the study of the disciplines "Higher Mathematics", "Discrete Mathematics", "Algorithms and Methods of Calculation", "Engineering and Computer Graphics". majoring in 123 Computer Engineering.

3. Content of the course

The discipline "Analytical Geometry and Linear Algebra" involves the study of the following topics:

Topic 1. Matrices and determinants

Topic 2. Fundamentals of vector algebra

Topic 3. Systems of linear algebraic equations
Topic 4. Line and plane
Topic 5. Lines and surfaces of the second order.
Topic 6. Linear spaces and subspaces.
Topic 7. Linear operators.
Topic 8. Quadratic forms.
Calculation work
Modular control work
Examination

4. Coursebooks and teaching resources

Basic literature:

1. *Linear Algebra and Analytic Geometry: teaching. textbook.* / Yu. K. Rudavskiy, P. P. Kostrobiy, H. P. Lunyk, D. V. Uhanska - Lviv: "Beskid Bit" Publishing House, 2002. — 262 p.
2. *Linear Algebra and Analytic Geometry: Education. manual* / V. V. Buldygin, I. V. Alekseeva, V. O. Gaidei, O. O. Dykhovychyny, N. R. Konovalova, L. B. Fedorova; under the editorship Prof. V. V. Buldighina. - K.: TViMS, 2011. — 224 p.
<http://matan.kpi.ua/public/files/Posibnyk%20LA+AG.pdf>
3. V. S. Charin, *Linear Algebra.* — K.: Technika, 2004. — 416 p.
4. *Linear Algebra and Analytic Geometry (additional chapters)* / V.I. Sushchuk-Slyusarenko. - K.: FAM NTUU "KPI", 2013. -188 p.
5. *Collection of problems in linear algebra and analytic geometry* / Yu. K. Rudavskiy, P.P. Kostrobiy, D. V. Uhanska and others; under the editorship Yu.K. Rudavskiy. - Lviv: "Beskid Bit" Publishing House, 2002. - 256 p.
6. *Analytical Geometry: computer workshop*/O.M. Neshchadym. - K.: "KPI named after Ihor Sikorsky", 2023.-149 p.
7. *Linear Algebra: computer workshop*/O.M. Neshchadym. - K.: "KPI named after Igor Sikorsky", 2024.-123 p.
8. *Analytical Geometry and Linear Algebra: a collection of Problems for Computational and Graphic Works*/ O.M. Neshchadym. - K.: "KPI named after Igor Sikorsky", 2023.-45 p.
The materials are freely available on the Internet.

Additional literature:

1. Lay D. C. *Linear Algebra and its Applications, 3rd updated edition.* Addison Wesley, 2005. — 576 p.
2. Nicholson W. K. *Linear Algebra With Applications, 3rd Edition, 1995.* — 540 p.
3. Poole D. *Linear Algebra: A Modern Introduction, 2nd edition.* Brooks/Cole, 2006. — 712 p.
4. *Linear algebra and analytical geometry. Practicum* / Composer: I.V. Alekseeva, V.O. Heidei, O.O. Dykhovychyny, L.B. Fedorova. - K.: NTUU "KPI", 2013. - 180 p.
<https://matan.kpi.ua/public/files/PraktykumLAAG.pdf>

5. Methodology

<i>№ s/n</i>	<i>Type of training session</i>	<i>Description of the lesson</i>
Topic 1. Matrices and determinants		
1	<i>Lecture 1. Matrices and determinants</i>	<i>Matrices, their types. Actions with matrices. Determinant and minors of matrices. Rules for calculating determinants of higher orders. Properties of determinants. Tasks for self-study: item 6, № 1.</i>
2	<i>Practical lesson 1.</i>	<i>Tasks: matrices and actions with them, rules for calculating determinants. Tasks for self-study: item 6, №2.</i>
3	<i>Lecture 2. The rank of the matrix. Inverse matrix. Matrix equations.</i>	<i>The rank of the matrix and methods of finding it (the method of elementary transformations, the method of circumferential minors). Finding the inverse matrix. Solving matrix equations. Tasks for self-study: item 6, № 3.</i>
4	<i>Practical lesson 2.</i>	<i>Tasks: calculating the inverse matrix, solving matrix equations, finding the rank of the matrix. Tasks for self-study: item 6, №4.</i>
Topic 2. Fundamentals of vector algebra		
5	<i>Lecture 3. Fundamentals of vector algebra</i>	<i>Linear operations on vectors, types of vectors, linear dependence of vectors. Basis. Linear independence of the vector system. Calculations in coordinates. Tasks for self-study: item 6, № 5, 38.</i>
6	<i>Practical lesson 3.</i>	<i>Tasks: linear operations on vectors, linear independence of the system of vectors. Tasks for self-study: item 6, № 6.</i>
7	<i>Lecture 4. Product of vectors and their application. Coordinate systems</i>	<i>Product of vectors: scalar, vector, mixed; their calculation and application. Tasks for self-study: item 6, № 7, 42.</i>
8	<i>Practical lesson 4.</i>	<i>Tasks: calculation of scalar, vector and mixed products of vectors; their application. Tasks for self-study: item 6, № 8, 40</i>
Topic 3. Systems of linear algebraic equations		
9	<i>Lecture 5. Systems of linear algebraic equations.</i>	<i>Systems of linear algebraic equations. Record forms. Kronecker-Capelli theorem. Cramer's formulas. Matrix way of solving systems Tasks for self-study: item 6, № 9.</i>
10	<i>Practical lesson 5.</i>	<i>Task: solving certain SLARs according to Cramer's formulas and matrix method. Tasks for self-study: item 6, № 10.</i>

11	Lecture 6. Gauss method. Homogeneous SLAR. Heterogeneous SLAR. Gauss-Giordano method.	Gauss method of research and solution of SLAR. Homogeneous SLAR. Fundamental system of solutions. Heterogeneous system of linear algebraic equations. General and partial solutions. Tasks for self-study: item 6, № 11.
12	Practical lesson 6.	Tasks: research and solution of SLAR by Gauss method, finding the fundamental system of solutions of homogeneous systems. Tasks for self-study: item 6, № 12.
Topic 4. Line and plane		
13	Lecture 7. A straight line on a plane	Analytical geometry on the plane: equation of a line, beam of lines. The main types of tasks. Division of a segment in a given ratio. Study of a straight line on a plane. Construction of curves in the polar coordinate system. Tasks for self-study: item 6, № 13, 39.
14	Practical lesson 7.	Objectives: research and solution of SLAR by Gauss-Giordano method, finding general and partial solutions of inhomogeneous systems. Tasks for self-study: item 6, № 14.
15	Lecture 8. Straight line and plane in space	Surfaces and their equations. Varieties of plane and line equations in space. The angle between two planes. The distance from the point to the plane. The angle between two lines. Tasks for self-study: item 6, № 15.
16	Practical lesson 8.	Task: varieties of a straight line on a plane, main types of problems, research of a straight line on a plane. Construction of lines in the polar coordinate system. Tasks for self-study: item 6, № 16.
17	Lecture 9. Mutual location of lines and planes	Analysis of the relative position of two lines, two planes, a line and a plane in space. The distance between two passing lines. The angle between a line and a plane. Binding of planes. Tasks for self-study: item 6, № 17.
18	Practical lesson 9.	Tasks: types of equations of plane and line in space, basic types of problems. Tasks for self-study: item 6, № 18.
Topic 5. Lines and surfaces of the second order		
19	Lecture 10. Second order curves	Lines of the second order: circle, ellipse, hyperbola, parabola. Tasks for self-study: item 6, № 19, 41.
20	Practical lesson 10.	Tasks: problems on the relative position of planes, lines and lines and planes in space.

		<i>Tasks for self-study: item 6, № 20.</i>
21	<i>Lecture 11. Algebraic lines of the second order on the plane. Surfaces of the second order</i>	<i>Reduction of the general equation of a line of the second order to the canonical form. Surface rotation and compression transformation. Ellipsoids, hyperboloids, paraboloids, cylindrical and conical surfaces. The cross-sectional method of surface shape research. Application of analytical geometry in cosmonautics, mechanics. Curves and surfaces in nature and technology. Tasks for self-study: item 6, № 21.</i>
22	<i>Practical lesson 11.</i>	<i>Tasks: problems for finding and constructing second-order lines on a plane (circle, ellipse, hyperbola, parabola). Tasks for self-study: item 6, № 22, 45.</i>
Topic 6. Linear spaces and subspaces.		
23	<i>Lecture 12. Linear spaces and subspaces</i>	<i>Concept of linear space and subspace. Basis and dimension of linear space. Transformation of vector coordinates when changing the basis. Tasks for self-study: item 6, № 23.</i>
24	<i>Practical lesson 12.</i>	<i>Task: problems on reducing the general equations of second-order curves to the canonical form. Finding, researching and constructing second-order surfaces. Tasks for self-study: item 6, № 24.</i>
25	<i>Lecture 13. Euclidean spaces</i>	<i>Athenian, Euclidean and arithmetic spaces. Orthogonal systems of vectors and an orthonormal basis. Gram-Schmidt orthogonalization process. Gram matrix. Orthogonal addition. Tasks for self-study: item 6, № 25, 43.</i>
26	<i>Practical lesson 13.</i>	<i>Task: to find out the linearity of space, the transformation of the coordinates of the vector when replacing the basis. Tasks for self-study: item 6, № 26.</i>
Topic 7. Linear operators.		
27	<i>Lecture 14. Linear operators</i>	<i>Definition and properties of a linear operator. Linear operator matrix. Changing the linear operator matrix when moving to a new basis. Operations on linear operators. The image and kernel of a linear operator. Inverse operator. Tasks for self-study: item 6, № 27.</i>
28	<i>Practical lesson 14.</i>	<i>Task: finding the matrix of a linear operator, the transition matrix when changing the basis, the matrix of the operator in the new basis, the image and kernel of the linear operator, the inverse operator. Tasks for self-study: item 6, № 28.</i>
29	<i>Lecture 15. Eigenvalues and eigenvectors of a matrix of a</i>	<i>Characteristic equation of the matrix. Eigenvectors of a linear operator. Calculation of eigenvalues and</i>

	<i>linear operator.</i>	<i>eigenvectors. Diagonalization of matrices. Tasks for self-study: item 6, № 29.</i>
30	<i>Practical lesson 15.</i>	<i>Task: Calculation of eigenvalues and eigenvectors of a matrix of a linear operator, diagonalization of matrices. Tasks for self-study: item 6, № 30.</i>
31	<i>Lecture 16. Linear operators in Euclidean spaces</i>	<i>Conjugate operator. Self-adjoint operators and their matrices. Orthogonal matrices and operators. Diagonalization of symmetric matrices by orthogonal transformation. Tasks for self-study: item 6, № 31.</i>
32	<i>Practical lesson 16.</i>	<i>Task: study of vectors for orthogonality, construction of orthonormal bases, composition of the Gram matrix. Conjugate and self-conjugate operators and their matrices, diagonalization of symmetric matrices by orthogonal transformation. Tasks for self-study: item 6, № 32.</i>
Topic 8. Quadratic forms.		
33	<i>Lecture 17. Quadratic forms</i>	<i>Quadratic forms of general appearance. Quadratic forms of the canonical form. Lagrange and Jacobi methods of reducing the quadratic form to the canonical form. Orthogonal transformations of quadratic forms. The law of inertia. Sylvester's criterion. Tasks for self-study: item 6, № 33, 44.</i>
34	<i>Practical lesson 17.</i>	<i>Task: matrix of quadratic form, reduction of quadratic forms to canonical form by Lagrange and Jacobi methods; orthogonal transformations of quadratic forms; research on the significance of quadratic forms. Tasks for self-study: item 6, № 34, 36.</i>
35	<i>Lecture 18. Curves and surfaces of the second order in Euclidean space.</i>	<i>Changing the coordinate system. Simplification of equations of the curve and surface of the second order. Invariants of the quadratic form. Scheme of bringing the curves and surfaces of the 2nd order to the canonical form. Classification of lines and surfaces of the 2nd order. Tasks for self-study: item 6, № 35, 46.</i>
36	<i>Practical lesson 18.</i>	<i>Task: reduction of the equation of the second order curve to the canonical form, construction of curves. Summing up. Tasks for self-study: Item 6, № 37.</i>
<i>Modular control work, calculation work</i>		

6. Self-study

The discipline "Analytical Geometry and Linear Algebra" is based on independent preparations for classroom classes on theoretical and practical topics.

No s/n	The name of the topic that is submitted for independent study	Number of hours	literature
1	Preparation for the lecture 1	1	1, p. 7-22; 2, p. 9-23
2	Preparation for a practical lesson 1	1,5	6, № 1.2-1.34 (even); 8, typical calculation 1: tasks 1, 2
3	Preparation for the lecture 2	1	1, p. 26-30, 34-40; 2, p. 24-31
4	Preparation for a practical lesson 2	1,5	6, № 2.2-2.28 (even); 8, typical calculation 1: task 3
5	Preparation for the lecture 3	1	1, p. 56-73; 2, p. 57-74
6	Preparation for a practical lesson 3	1,5	6, № 3.2-3.28 (even)
7	Preparation for the lecture 4	1	1, p. 74-787; 2, p. 75-89
8	Preparation for a practical lesson 4	1,5	6, № 4.2-4.32 (even); 8, typical calculation 1: task 4
9	Preparation for the lecture 5	1	1, p. 23-25, 41-46; 2, p. 34-40
10	Preparation for a practical lesson 5	1,5	6, № 5.2-5.18 (even); 8, typical calculation 1: task 5
11	Preparation for the lecture 6	1	2, p. 41-43; 3, p. 165-180
12	Preparation for a practical lesson 6	1,5	6, № 6.2-6.20 (even); 8, typical calculation 2: task 11
13	Preparation for the lecture 7	1	1, p. 54-56; 2, p. 43-46
14	Preparation for a practical lesson 7	1,5	6, № 7.2-7.18 (even); 8, typical calculation 2: task 12
15	Preparation for the lecture 8	1	1, p. 92-112; 2, p. 136-139
16	Preparation for a practical lesson 8	1,5	6, № 8.2-8.24 (even); 8, typical calculation 1: tasks 6, 7
17	Preparation for the lecture 9	1	1, p. 135-153; 2, p. 129-138
18	Preparation for a practical lesson 9	1,5	6, № 9.2-9.22 (even);

			8, typical calculation 1: task 9
19	Preparation for the lecture 10	1	1, p. 154-172; 2, p. 139-150
20	Preparation for a practical lesson 10	1,5	6, № 10.2-10.22 (even); 8, typical calculation 1: task 10
21	Preparation for the lecture 11	1	1, p. 113-130; 2, p. 150-156
22	Preparation for a practical lesson 11	1,5	6, № 11.2-11.26 (even); 8, typical calculation 1: task 8
23	Preparation for the lecture 12	1	1, p. 187-196; 2, p. 163-175
24	Preparation for a practical lesson 12	1,5	6, № 12.2-12.24 (even)
25	Preparation for the lecture 13	1	1, p. 197-204; 3, p. 126-164
26	Preparation for a practical lesson 13	1,5	7, № 13.2-13.20 (even); 8, typical calculation 2: tasks 13, 14
27	Preparation for the lecture 14	1	1, p. 205-224; 3, p. 231-253
28	Preparation for a practical lesson 14	1,5	7, № 14.2-14.12 (even); 8, typical calculation 2: tasks 16, 17
29	Preparation for the lecture 15	1	1, p. 232-243; 3, p. 254-269
30	Preparation for a practical lesson 15	1,5	7, № 15.2-15.8 (even); 8, typical calculation 1: task 18
31	Preparation for the lecture 16	1	1, p. 225-231; 3, p. 317-336
32	Preparation for a practical lesson 16	1,5	7, № 16.2-16.18 (even); 8, typical calculation 2: task 15
33	Preparation for the lecture 17	1	1, p. 246-248; 3, p. 214-230
34	Preparation for a practical lesson 17	1,5	7, № 17.2-17.16 (even); 8, typical calculation 2: tasks 19, 20
35	Preparation for the lecture 18	1	1, p. 249-260
36	Preparation for modular control work	4	7, № 18.2-18.12 (even)
37	Exam preparation	14	
38	<i>n</i> -dimensional linear spaces.	2	3, p. 138-156
39	Polar, cylindrical and spherical coordinate systems.	2	1, p. 125-130
40	Double vector product and its application.	0,5	1, p. 88-91
41	Construction of curves in the polar coordinate system.	2	1, p. 335-337

	<i>Equations of second-order curves in the polar coordinate system.</i>		
42	<i>Application of vector algebra</i>	1	2, p. 103-110
43	<i>Gram matrix and determinant.</i>	2	3, p. 92-94
44	<i>Lagrange and Jacobi methods of reducing the equation of the second order curve to the canonical form.</i>	2	3, p. 217-220
45	<i>Practical applications of analytical geometry.</i>	3	2, p. 181-190
46	<i>Application of linear algebra.</i>	3	2, p. 46-50

Policy and Assessment

7. Course policy

- *Attending lectures and practical classes is mandatory.*
 - *Rules of behavior in classes: activity, respect for those present, turning off phones.*
 - *Adherence to the policy of academic integrity.*
 - *Rules for the protection of calculation works: the works must be performed according to the option of the student of education, which is determined by his number in the group list. In some cases, option numbers can be assigned by the teacher.*
 - *The rules for assigning incentive and penalty points are as follows.*
- Incentive points are awarded for:*
- *accurate and complete answers in blitz polls based on lecture materials (maximum number of points for all polls - 3 points);*
 - *a creative approach when performing calculation works (maximum number of points for all works – 2 points).*
- Penalty points are calculated for:*
- *plagiarism (the presented calculation-graphic or control work does not correspond to the version, the identity of the works): -5 points for each attempt;*
 - *untimely completed calculation and graphic work (- 2 points).*

8. Types of control and rating system for evaluating learning outcomes (RSO)

*During the semester, students receive points for **answering practical classes**. Number of answers per semester per student (on average 5): maximum number of points per answer: 2 points.*

Evaluation criteria:

2 points – the answer is correct;

1 point – there are inaccuracies in the answer, but in general the answer is correct;

0 points - there is no answer or the answer is incorrect.

The maximum number of points for answers in practical classes:

2 points × 5 answers = 10 points.

In the semester, colloquium: 5 points (indentation is specified in the task). Maximum number of points for both colloquia (R2): 5 points × 2 count. = 10 points.

Modular control work is divided into two control works; maximum number of points for each test: 10 points (dilution of tasks is specified in the testa blitz survey (colloquium) is held based on the lecture material of each of the two sections. The maximum number of points for the colloquium: 5 points (the breakdown is indicated in the task). The maximum number of points for both colloquiums: 5 points × 2 col. = 10 points.

In the semester, a **blitz survey (colloquium)** is held based on the lecture material of each of the two sections. The maximum number of points for the colloquium: 5 points (the breakdown is indicated in the task). The maximum number of points for both colloquiums: 5 points × 2 col. = 10 points.

The modular control work is divided into two control works; the maximum number of points for each test: 10 points (the breakdown of tasks is indicated in the test).

Evaluation criteria:

9-10 points – the decision is correct;

6-8 points – the solution has flaws;

2-5 points – there are errors in the decision, but the course of the decision is correct;

0-1 point – there is no solution or the solution is incorrect.

The maximum number of points for modular control: 10 points × 2 cr = 20 points.

During the semester, students perform **calculation work**. The maximum number of points for the calculation work: 20 points.

Points are awarded for:

- control work - protection of calculation work: 0-10 points;

- quality of calculation work: 0-10 points.

Evaluation criteria of the control:

8-10 points – the answer is correct, well-argued;

5-7 points - in general, the answer is correct, but has shortcomings;

2-4 points – there are minor errors in the answer;

0-1 points – there are significant errors in the answer; no answer or the answer is incorrect.

Performance evaluation criteria:

8-10 points – the work was performed at a high level, in full;

5-7 points – the work is done qualitatively, in full, but has shortcomings;

1-4 points – the work is completed in full, but contains significant errors; the work is incomplete, contains minor errors;

0 points - work not done.

The maximum number of points for the execution and protection of calculation work:

10 points + 10 points = 20 points.

The sum of rating points of control measures during the semester is:

$RS = R_{practice} + R_{kol} + R_{MKR} + R_{RRR} + R_{interview} - R_{shtr} = 10 + 10 + 20 + 20 + 0 - 0 = 60$ points.

The examination component of the scale is equal to 40% of R, namely: $RE = 40$ points.

Thus, the rating scale for the discipline is: $R = RS + RE = 100$ points.

Calendar control: is carried out twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements.

At the **first certification** (8th week), the student receives "certified" if his current rating is at least 12 points (40% of the maximum number of points a student can receive before the first certification).

At the **second certification** (14th week), the student receives "certified" if his current rating is at least 25 points (50% of the maximum number of points a student can receive before the second certification).

Semester control: exam. A necessary condition for admission to the exam is a student's semester rating (rc) of not less than 60% of RS , i.e. 36 points.

The maximum number of points for the exam: 40 points (two theoretical questions of 5 points each; three problems of 10 points each).

Criteria for examination evaluation of a theoretical question:

5 – correct substantive answer to a theoretical question, proof of theorems where necessary;

4 – the answer has minor flaws;

3 – abbreviated correct answer to the ticket question;

1-2 – basic definitions and examples are given;

0 – missing or incorrect answer to the theoretical question.

Criteria for examination assessment of the problem:

9-10 – a correct meaningful answer, the necessary explanations are given;

7-8 – the answer has minor flaws;

4-6 – there are no necessary solution steps, sloppy design of the solution;

1-3 – some minor solution steps are given;

0 - there is no solution, or the solution does not meet the condition of the problem.

The student's overall rating is defined as the sum of the student's semester rating *RS* and points *RE* obtained on the exam. The final grade is assigned according to the table (Table of correspondence of rating points to grades on the university scale):

Score	Grade
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Sufficient
Below 60	Fail
Course requirements are not met	Not Graded

9. Additional information about the course

The list of questions to be submitted for semester control is given in Appendix 1.

Syllabus of the course

Is designed by teacher *PhD., Associate Professor, Alexandr Neschadym*

Adopted by Computer Systems Software Department (protocol № 14, 15 May 2024)

Approved by the Faculty Board of Methodology (protocol № 12, 21 June 2024)