**Federal state educational budgetary institution**

**of higher education**

**"FINANCIAL UNIVERSITY**

**UNDER THE GOVERNMENT OF THE RUSSIAN FEDERATION"**

**(Financial University)**

**Department of Mathematics**

**Shandra Igor Georgievich**

 **Mathematics**

**SYLLABUS**

***Level of Study:*** *Bachelor’s Degree*

***Field of Study:*** *38.03.01 - "Economics"*

**Moscow 2021**

**Federal Public Education Budget Office**

**Higher education**

**"Financial UNIVERSITY**

**Government of the Russian Federation"**

**(Financial University)**

**Department of Mathematics**

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|  |  **Approved** Rector \_\_\_\_\_\_\_\_\_\_\_\_M.A. Eskindarov" "2021 |

**Shandra I.G.**

**Mathematics**

**SYLLABUS**

***Level of Study:*** *Bachelor’s Degree*

***Field of Study:*** *38.03.01 - "Economics"*

***Study Programs:*** *International Finance,* ***International Business: Taxation and Accounting*** *(in English)*

*Recommended by the Scientific Council of the Faculty of Information Technology and Big Data Analysis*

*(Protocol No27 of 17.06.2021)*

*Approved by the Scientific Council of the Department of Mathematics(protocol No.12 of 02.06.2021)*

**Moscow 2021**

 **Reviewer:** Rylov A.A. Ph.D., Associate Professor, Department of Mathematics

**Shandra I.G. Mathematics.** A working discipline program for students studying in the Field of Study 38.03.01 "Economics" (for all study programs in English). − M.: Financial University under the Government of the Russian Federation, 2021. − 29 pp.

 Subject "Mathematics" is a discipline of the Mathematics and Informatics Cycle of the Field of Study 38.03.01 "Economics" (for all study programs in English).

The subject's syllabus defines its purpose, place in the structure of the study program, requirements for the results of subject development, the content of the program, the subject of practical training, forms of self-employment, evaluation tools for current monitoring and intermediate certification, educational and educational and information support.

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***Igor Georgievich Shandra***

**Mathematics**

*Syllabus*

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# 1. Name of a subject: Mathematics.

# 2. Mapping of learning outcomes (list of competences), with the relevant indicators described and subject learning outcomes indicated

The subject Mathematics provides the tools for the formation of the following competencies: PKN-3, UK-10.

Table 1

|  |  |  |  |
| --- | --- | --- | --- |
| **Competence code** | **Competence** | **Competence development indicators** | **Learning outcomes (skills[[1]](#footnote-1), and knowledge) and indicators that show competence development** |
| **PKN-3** | The ability to collect, process and statistical analysis of data, apply mathematical methods to solve standard professional financial and economic problems, interpret the results. | 1. Collects, processes and analyses data to address financial and economic challenges. | ***Knowledge:*** the main ways to collect, process information, ways of mathematical analysis of data.***Skills:*** apply mathematical methods to set and solve analysis problems when evaluating the best ways and methods to achieve goals. |
| 2. Formulates mathematical productions of financial and economic problems, moves from economic tasks to mathematical models. | ***Knowledge:*** fundamental concepts, ideas of algebra and geometry, mathematical analysis.***Skills:*** apply appropriate mathematical algorithms and methods to simulate economic problems. |
| 3. Systematically approaches the choice of mathematical methods and information technologies to solve specific financial and economic problems in the professional field. | ***Knowledge:*** basic fundamental mathematical ideas, concepts and principles of mathematical modeling. ***Skills:*** apply appropriate mathematical algorithms and methods to simulate economic problems in the professional field. |
| 4. Analyzes the results of the study of mathematical models of financial and economic problems and makes on their basis quantitative and qualitative conclusions and recommendations on financial and economic decisions. | ***Knowledge:*** fundamental concepts, ideas of algebra and geometry, mathematical analysis: to apply the tools of modern mathematics to the analysis.***Skills:*** of the results of the study of mathematical models of financial and economic problems and to draw on their basis quantitative and qualitative conclusions and recommendations on making financial and economic decisions. |
| **UK-10** | The ability to search, critically analyze, generalize and organize information, use a systematic approach to solve problems | 1. Clearly describes the composition and structure of the required data and information, competently implements the processes of their collection, processing and interpretation | ***Knowledge:*** fundamental concepts, ideas and tools of algebra and geometry, mathematical analysis.***Skills:*** *solve* typical mathematical problems used in making financial and economic decisions. |
| 2. Substantiates the essence of what is happening, reveals patterns, understands the nature of variability | ***Knowledge:*** fundamental concepts, ideas and tools of algebra and geometry, mathematical analysis.***Skills:*** to select adequate mathematical methods and models for staging, solving and analyzing the results received in specific applied tasks. |
| 3. Forms a classification trait, identifies the groups corresponding to it of homogeneous "objects", identifies the common properties of elements of these groups, evaluates the completeness of classification results, shows the application purpose of classification groups | ***Knowledge:*** fundamental concepts, ideas and tools of algebra and geometry, mathematical analysis.***Skills:*** apply mathematical methods to staging, solving and interpreting the results obtained in the tasks of modeling and describing professional activities. |
| 4. Competently, logically, reasonedly forms their own judgments and assessments. Distinguishes facts from opinions, interpretations, assessments, etc. in the reasoning of other participants | ***Knowledge:*** fundamental concepts, ideas of algebra and geometry, mathematical analysis.***Skills:*** to apply mathematical methods for staging and making financial and economic decisions. |
| 5. Argued and logically presents his point of view through and on the basis of a systematic description | ***Knowledge:*** fundamental concepts, ideas of algebra and geometry, mathematical analysis.***Skills:*** apply appropriate mathematical algorithms and methods to model financial and economic processes and relationships. |

# 3. Place of the subject in the curriculum

The subject "Mathematics" is a subject of the Cycle of Mathematics and Informatics of the Field of Study 38.03.01 "Economics" (for all study programs).

The study of mathematics is based on knowledge obtained in the school course of mathematics or relevant subjects of secondary vocational education.

# 4. Workload in credits and academic hours, with class work (lectures and seminars) and self-study indicated

***Study Programs:*** *International Finance,* ***International Business: Taxation and Accounting (all profiles)*** *(in English), 2021.*

Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of work**  | **Total (in credits and hours)** | **Semester 1****(in hours)** | **Semester 2****(in hours)** |
| **Overall workload**  | **6/216**  | **108** | **108** |
| ***Class work***  | ***100*** | ***50*** | ***50*** |
| *Lectures*  | ***32*** | ***16*** | ***16*** |
| *Seminars, practicals*  | ***68*** | ***34*** | ***34*** |
| ***Self-study***  | ***116*** | ***58*** | ***58*** |
| Formative assessment  | **Control work** | **Control work** |
| Summative assessment  | **Final test**  | **Exam** |

# 5. Subject content (with the thematic components indicated).

# Subject content

**Section 1 - Mathematical Calculus**

**Topic 1. Number sets and functions**

Elements of the set theory. The quantors. Operations over sets: unification, intersection, difference, addition. Counting and countless sets. Bounded and unbounded sets.

Lots of natural, rational and real numbers. Complex numbers and actions above them. The module and the complex number argument. Algebraic and polar forms of recording of complex numbers.

The concept of function. The numerical function of one variable, graph of function. Properties of functions of one variable: even and odd, monotony.

Functional dependencies in the economy: utility functions, single-factor production functions, supply and demand functions. Medium-cost and the connection between them (*ATC = AVC* + *AFC*).*).*

**Topic 2. Limit and continuity**

Numerical sequences, sequence limit and its properties, monotonous, limited sequences. Geometric and arithmetic progressions.

Simple and compound interest. Accumulation and discounting. Continuous interest.

A spider-shaped model of the single-product market. Price sequence and its convergence.

The limit of function is at point and on infinity. One-way limits. Infinitely small and infinitely large functions. The first and second are wonderful limits. Comparison of infinitely large and infinitely small functions. Equivalent infinitely small and their use when calculating the limits.

Continuity of function at point and on set. Properties of continuous functions. Discontinuity points and their classification. Examples of continuous and dis continuous functions in the economy: cost function, dependence of the tax rate on income (case of proportional and progressive tax).

Asymptotes of graphics of function. Asymptotic behavior functions.

**Topic 3. Differential calculus of functions of one variable**

Derivative function, its geometric meaning, the properties of the derivative. Derivative of compound and implicitly assigned functions. Limits and averages in the economy: marginal and average costs, marginal and average productivity.

Medium and point elasticity of the function. The elasticity of supply and demand on price, the elasticity of demand on income.

Differentiation of function, the first differential and its geometric meaning. Approximate calculations using a differential.

The main theorems of differential calculus are the lemma Farm, the theorems of Rollia and Lagrange. The Lopital Rule of Disclosure is uncertainty.

The monotony of the function. A condition of monotony. Extreme function. Necessary and sufficient conditions of extreme. The task of maximizing profits. Modeling tax revenues to the budget. Laffer's curve.

The largest and smallest function value on the segment.

Derivatives and differentials of higher orders. Taylor's formula. McLorren's formula. The decomposition of elementary functions according to the McLoren formula.

The concavity of the graphics function. Inflection points.

A complete study of function and graphing using differential calculus.

**Topic 4. Integral calculus of the functions of one variable**

The original function. Undefinite integral. The main methods of integration: replacing the variable, integrating into parts. Integrating rational functions.

Definite integral. The Newton-Leibniz formula and its application. Production for a certain time at the specified law of instant production capacity.

The average function. Average productivity, average capital output.

Improper integrals. Integral Poisson.

**Topic 5. Multiple variables**

Space *Rn*. Sets in space *Rn*. Function of several variables. Examples of Function of several variables in the economy (utility function, multifactorial production functions (Cobb-Douglas function. The level surfaces (lines). Curves of indifference and isoquants.

The limit and continuity of the function of several variables.

Partial derivatives function of several variables. Differentiability and differential function of several variables.

Average and marginal productivity and capital output. Labor and capital elasticity ratios. Marginal rates for substitution of factors of production.

Derivative of a compound function, gradient.

Local extreme of functions of several variables. The necessary conditions of local extreme. A sufficient condition for the case of two independent variables.

Conditional extremum. The method of substitution. Lagrange multipliers method. The task of consumer choice, the economic meaning of the Lagrange multipliers.

Global extremum. Minimizing costs and maximizing the profits of a multi-product company.

Double integrals. The Reduction of the double integral to repeating integral.

**Topic 6. Number series**

The concept of numerical series. The convergence of the series. The sum of the serie. Eternal annuity.

**Topic 7. Differential equations**

Social and economic tasks leading to differential equations.

The general solution to the differential equation. Partial solutions to the differential equation. Cauchy Problem.

Equations with separating variables. The homogeneous equations of the first order. A first-order linear equation. Bernoulli's equation.

Linear differential equations with constant coefficients.

**Section 2 - Linear algebra**

**Topic 8.** **Systems of linear equations and inequalities**

A system of linear algebraic equations. A homogeneous and heterogeneous system of linear equations. Determining the solution of a system of linear equations. The equivalence of linear equation systems. Consistent and defined systems of linear equations. The Kroneker-Capelli theorem.

The study and solution of the system of linear equations by the Jordan-Gauss method. A general solution of a system of linear equations. Partial solutions of a system of linear equations. Basic solutions of the linear equation system.

A fundamental system of solutions to a homogeneous system of equations. General solutions to homogeneous and nonhomogeneous systems, the connection between them.

Straight line on a plane. Straight line and plane in space.

Systems of linear algebraic inequalities and their use in the economy: budget sets, restrictions on the use of resources.

Search for non-negative basic solutions for a system of linear equations. Simplex transformations.

**Topic 9.** **Vectors and matrices**

Arithmetic vectors and their use in the economy. Geometric interpretation of vectors. Linear operations over vectors. An inner product of vectors. Examples of inner product in the economy. The length of the vector. The angle between the vectors.

Matrices and their types. Linear operations over the matrix. Transposing the matrix. The product of the matrix. The properties of operations over the matrix.

Elementary transformations over rows and columns of matrix. The theorem is about reduction the arbitrary matrix to a step-by-step form. Matrix rank. The nondegeneracy of the square matrix.

Inverse matrix. The properties of the inverse matrix. Calculating the reverse matrix with elementary transformations.

The determinant of the square matrix. Minors and cofactors. Expansion of the determinant by line or column. The determinant properties. The criterion of the nondegeneracy of the matrix. Calculating the determinant through elementary transformations.

**Topic 10. Linear space**

Linear (vector) space. Linear dependence (independence) of the vector system. The basis and dimension of the linear space. Vector coordinates in a given base. Transformation of the matrix of a linear operator when replacing the basis. Transformation of vector coordinates when replacing the basis.

**Topic 11.** **Linear transformations and quadratic forms**

Linear transformations of the R*n* space (linear operators).

Linear operator matrix. Transformation of the matrix of a linear operator when replacing the basis.

The eigenvalues of the matrix. The characteristic polynomial of the matrix. The eigenvectors of the matrix.

Linear model of exchange (international trade model).

Symmetric matrices and quadratic forms. Reduction of the quadratic form to the normal and canonical form. Second-order curves.

**Theme1 2. Linear programming**

Linear production task. Formulation and various forms of writing a linear programming problem. Geometric interpretation of a linear programming problem.

# The canonical form of a linear programming problem. Feasible solutions. Properties of the domain of valid solutions. The algorithm of the simplex method of linear programming.

# The simplex method as a method of directed iteration of basic admissible solutions. The optimality criterion. Economic interpretation of linear programming problems, simplex method, and simplex estimates.

# A symmetric pair of dual problems. Economic interpretation of the dual problem.

# The main inequality of the duality theory, its economic interpretation. The small duality theorem. A sufficient condition for the optimality of a pair of mutually dual problems. The first and second basic duality theorems, their geometric and economic interpretation.

# An unsymmetric pair of dual problems.

# The third basic duality theorem, its geometric and economic interpretation. The area of stability of dual estimates.

# Transport task. A task that is dual to the transport one. Closed transport problem and its solution by the method of potentials. Economic interpretation of cell estimates, supplier and consumer potentials.

# A degenerate transport problem. Open transport task, fictitious suppliers and consumers.

#  Curriculum - thematic plan

|  |  |  |  |
| --- | --- | --- | --- |
| № | **The name of topic (sections) of the subject** | **Hours** | **Forms of current performance control** |
| **total**  | **Classroom work** | **Self-study work** |
| total: | Lectures | Seminars | Classes in interactive forms |
|  | Numerical sets and functions.  | 10 | 4 | 2 | 2 | 2 | 6 | Self-standingWork. Participation in solving problems on practicaloccupations. Discusssolved problems.  |
|  | Limit and continuity | 16 | 8 | 2 | 6 | 4 | 8 |
|  | Differential calculus of functions of one variable | 28 | 18 | 4 | 14 | 12 | 10 |
|  | Integral calculus of the functions of one variable | 24 | 14 | 4 | 10 | 8 | 10 |
|  | Several variables | 34 | 16 | 6 | 10 | 8 | 18 |
|  | Number series | 4 | 2 | 0 | 2 | 2 | 2 |
|  | Differential equations | 12 | 4 | 2 | 2 | 2 | 8 |
|  | Systems of linear equations and inequalities | 14 | 4 | 0 | 4 | 4 | 10 | Self-standingWork. Participation in solving problems on practicaloccupations. Discusssolved problems.  |
|  | Vectors and matrices | 18 | 8 | 4 | 4 | 4 | 10 |
|  | linear space | 6 | 4 | 2 | 2 | 2 | 2 |
|  | Linear transformations and quadratic forms | 16 | 6 | 2 | 4 | 4 | 10 |
|  | Linear programming | 34 | 12 | 4 | 8 | 8 | 22 |
|  | Overall discipline | **216** | **100** | **32** | **68** | **60** | **116** | According to the curriculum: control work |
|  | **Total %** |  |  |  |  | **60%** |  |  |

#  Content of seminars, workshops

|  |  |  |
| --- | --- | --- |
| **Naming themes (sections) of discipline** | **List of questions to discuss in seminary, practice sessions, recommended sources from section 8.9 (indicated section and serial number of the source)** | **Forms of classes** |
| **1. Numerical sets and functions.**  | Elements of the set theory. The quantors. Operations over sets: unification, intersection, difference, addition. End, counting and countless sets. Limited and unlimited sets. Lots of natural, whole, rational and valid numbers. Complex numbers and actions above them. The module and the complex number argument. Algebraic and trigonometry forms of recording of complex numbers. The concept of function. The numerical function of one variable. How functions are set. graph of function. Properties of functions of one variable: parity and oddity, monotony, bulge, frequency, limitations.Functional dependencies in the economy: utility functions, single-factor manufacturing functions, supply and demand functions. Medium-cost functions and the connection between them (ATC and AVC q AFC). | Working with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **2. Limit and continuity.**  | Numerical sequences, sequence limit and its properties, monotonous, limited sequences. Geometric and arithmetic progressions.Simple and complex interest. Promotion and discounting. Continuous interest accrual. A spider-shaped model of the single-product market. Price sequence and its convergence. | Working with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The limit of function is at point and on infinity. One-way limits. Infinitely small and infinitely large functions. The first and second are wonderful limits. Comparison of infinitely large and infinitely small functions. Equivalent infinitely small and their use when calculating the limits.   | Working with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Continuity of function at point and on set. Properties of continuous functions. Break points and their classification. Examples of continuous and disruptive functions in the economy: cost function, dependence of the tax rate on income (case of proportional and progressive tax).Asymptots graphics function. Asymptotic behavior functions Thornquist's demand. | Working with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **3. Differential calculus of functions of one variable**  | Derivative function, its geometric meaning, the properties of the derivative. Derivative of complex and implicitly assigned functions. Limits and averages in the economy: marginal and average costs, marginal and average productivity. Medium and point elasticity of the function. The elasticity of supply and demand on price, the elasticity of demand on income. | Working with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Differentiation of function, the first differential and its geometric meaning. Approximate calculations using a differential.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The main theorems of differential calculus are the lemma Farm, the theorems of Rollia and Lagrange. The Lopital Rule of Disclosure is uncertainty.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The monotony of the function. A condition of monotony. Extreme function. Necessary and sufficient conditions of extreme. The task of maximizing profits. Modeling tax revenues to the budget. Laffer's curve.The largest and smallest function value on the segment. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Derivatives and differentials of higher orders. Taylor's formula. McLorren's formula. The decomposition of elementary functions according to the McLoren formula. The bulge of the graphics function. Inflection points.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| A complete study of function and graphing using differential calculus.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **4. Integral calculus of the functions of one variable** | The original function. Uncertain integral. The main methods of integration: replacing the variable, integrating into parts.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The main methods of integration: integration into parts.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Integrating rational functions. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Definite integral. The Newton-Leibniz formula and its application. Production for a certain time at the specified law of instant production capacity. The average function. Average productivity, average capital output. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Improper integrals. Poisson Integral. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homeworkDoing control work tasks |
| **5. Several variables** | Rn. Space Set in Rn Space. Several variables. Examples of multiple variables in the economy include utility function, multifactorial production functions (Cobb-Douglas). The level surfaces (lines) of the function. Curves of indifference and isoquants. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The limit and continuity of the function of several variables. Private derivatives function in multiple variables. Differentiability and differential function of several variables. Average and marginal productivity and capital output. Labor and capital elasticity ratios. Margin rates for substitution of factors of production.Derivative of a compound function, gradient. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Local extreme functions multiple variables. The necessary conditions of local extreme. A sufficient condition for the case of two independent variables.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Conditional extremum. The wildcard method. Lagrange multipliers method. The problem of consumer choice, the economic meaning of the Lagrange multipliers.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Global extremum. Minimizing costs and maximizing the profits of a multi-product company. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Kray integrals. The mix-up has been re-integrated. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **6. Numbers series** | The concept of numerical series. The convergence of the series. The sum of the series. Perpetual annuities. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **7. Differential equations** | Social and economic tasks leading to differential equations. The general solution to the differential equation. Partial solutions to the differential equation. Cauchy problem.Equations with separating variables. The homogeneous equations of the first order. A first-order linear equation. Bernoulli's equation.Linear differential equations with constant coefficients. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **8. Systems of linear equations and inequalities** | A system of linear algebraic equations. A homogeneous and heterogeneous system of linear equations. Determining the solution of a system of linear equations. The equivalence of linear equation systems. Joint and defined systems of linear equations. The Kroneker-Capelli theorem. The study and solution of the system of linear equations by the Jordan-Gauss method. A common solution to a system of linear equations. Private solutions to a system of linear equations. Baseline solutions to the linear equation system. A fundamental system of solutions to a homogeneous system of equations. Common solutions to homogeneous and heterogeneous systems, the connection between them. Straight on a plane. Straight and plane in space. Systems of linear algebraic inequalities and their use in the economy: budget sets, restrictions on the use of resources.Search for non-negative baseline solutions for a system of linear equations. Simplex transformations | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **9. Vectors and Matrices**  | Arithmetic vectors and their use in the economy. Geometric interpretation of vectors. Linear operations over vectors. An inner product of vectors. Examples of inner product in the economy. The length of the vector. The angle between the vectors.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Matrix and their species. Linear operations over the matrix. Transposing the matrix. The work of the matrix. The properties of operations over the matrix.Elementary transformations over rows and columns of matrix. The theorem is about bringing the arbitrary matrix to a step-by-step form. matrix rank. The degenerative of the square matrix.inverse matrix. The properties of the reverse matrix. Calculating the reverse matrix with elementary transformations.The determiner of the square matrix. Minors and algebraic supplements. Decomposing the determiner by line or column. The definer's properties. The criterion of the unbornness of the matrix. Calculating the determinant through elementary transformations. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **10. Linear space and linear transformations** | Linear (vector) space. Linear dependence (independence) of the vector system. The basis and dimension of the linear space. Vector coordinates in a given base. Convert vector coordinates when the base is replaced. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **11. Linear еoperators and quadratic forms** | Linear Rn space conversions (linear operators). The line operator's matrix. Transform the linear operator matrix when the baseline is replaced. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The matrix's own values. Characteristic multi-member matrix. The matrix's own vectors. Linear model of exchange (international trade model). | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| Symmetry matrix and quadratic forms. Bringing the quadratic form to normal and canonical form. Second-order curves.  | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| **12. Linear programming** | Examples of linear optimization models in the economy. Line production task. Canonical forms of recording the task of linear programming. Geometric interpretation of the problem of linear programming. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| The canonical form of the linear programming problem. Feasible solutions. Properties of the area of acceptable solutions. The algorithm of the simplex method of linear programming. The simplex method as a method of aiming to bust the basic acceptable solutions. The criterion of optimality. Economic interpretation of the task of linear programming, simplex method, simplex estimates. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |
| A symmetrical pair of dual tasks. The economic interpretation of the dual task.The main inequality of the theory of duality, its economic interpretation. A small theorem of duality. A sufficient condition for the optimality of a pair of mutually dual tasks. The first and second main theorems of duality, their geometric and economic interpretation.An asymmetrical pair of dual tasks. The third basic theorem of duality, its geometric and economic interpretation. The area of sustainability of dual assessments. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homeworkDoing control work tasks |
| Transport problem. The problem is dual to transport. Closed transport problem and its solution by the method of potentials. Economic interpretation of cell assessments, supplier and consumer potentials.An outstanding transport problem. Fake deliveries. Open transport problem, fictitious suppliers and consumers. | Work with the text of the lecture, to analyze questions on the topic of the class;Study of the literary sources recommended for occupation;Preparing for seminary and practice;Doing homework |

# 6. List of teaching and methodological materials needed for the students self-study

# 6.1. List of questions for student self-study and types of out-of-class activities

|  |  |  |
| --- | --- | --- |
| **Itemized subject content**  | **Questions the students should answer within the self-study process**  | **Types of out-of-class activities** |
| **Section 1. calculus** |
| Number sets and functions | Arithmetic actions with complex numbers. Representation of a complex number in algebraic and trigonometry form. | Work with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Limit and continuity | Calculating the limits of numerical sequential, functions on infinity and at point. Identify break points and function graph asymptote. | Ra bot with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Differential calculus of functions of one variable | Calculating derivatives. Finding limits according to the Lopital rule.And the consequence of the function and the construction of its graphics (intervals of monotony and extremes, intervals of bulge and inflection points, asymptots). Identify the highest and least function value on the segment | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Integral calculus of the functions of one variable | Finding vague integrals by different methods. Calculating certain integrals according to the Newton-Leibniz formula, converging non-special integrals, areas of flat shapes. | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Function of several variables | Calculating private derivatives, a derivative of a complex function, derivative in direction and gradient. Finding local and conditional extremes, Identifying the highest and lowest values. Calculating multiples of integrals. | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Number series | The concept of numerical rows. The convergence of the series. The amount of the row. Eternal rent. | Working with the text of the lecture, parsing questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Differential equations | Solving first-order differential equations and second-order linear differential equations with constant odds | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| **Section 2. linear algebra** |  |
| Systems of linear equations and inequalities | Solving the systems of linear algebraic equations by the Jordan-Gauss method. Straight on a plane, straight and plane in space | Studying with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Vectors and matrices | Solving problems on operations with vectors and matrixes. Calculating the rank of the matrix, the reverse matrix.  | Studying with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| linear space | Research of the system of vectors on linear dependence. The basis and dimension of the space.  | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Linear transformations and quadratic forms | Finding your own values and own matrix vectors. Solving problems on the reducing of a quadratic form.  | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |
| Linear programming | Solving linear programming problems with graphic and simplex method. | Working with the text of the lecture, analysis of questions and assignments on the topic of the class;Studying the literary sources recommended for occupation. |

# 6.2. List of questions/assignments/topics for students’ preparation to formative assessment

**Example of control work (1 semester).**

1. Calculate the function limit.

2. Calculate the function limit.

The dependence of demand on a product on its price is expressed by function. Find demand for goods, marginal demand and point elasticity of demand at a price of *p*. What is the average elasticity of demand at a price, with an increase in price by 5%?

4. Find a derivative of an implicitly defined function.

5. The total cost of issuing *q* units of production is expressed by the function . 

1) Find a minimum: (a) total costs; b) average costs.

2) Build a marginal cost graph.

3) Make a function of income from the sale of units of goods at the price of *p*.

4) Find the profit .

5) Build income and profit graphs.

6. Explore the function and plot the graph.

7. The productivity of one worker per day is described by a function where t is hours time, 0 ≤ t ≤ 8. Determine the output in 20 business days by a team of 6 people.

8. Calculate the integral.

**Example of control work (2 semesters).**

1. Explore on extreme function.

2. The consumer utility function for two products is the type  where *x,* *y* − the number of goods purchased.

1) Determine the maximum usefulness of goods if the consumer has a budget in *I*=1899 D., and the prices of goods are 13 and 5, respectively.

2) Build the plot the graph function.

3) Picture the acceptable set, the curves of indifference and the optimal point.

4) Find the indifference curve equation on which the consumer's optimal point is located.

3. Solve the differential equation.

4. The matrix is given, and. 

Find the matrix 

5. Calculate the rank of the matrix.

6. Solve a system of linear algebraic equations and find at least two of its basic non-negative solutions



7. Determine whether international trade between the two countries is balanced if the national income vector of these countries



it's a structural matrix..

There are 100 kg of raw materials for the manufacture of two types of products. One product of the first type is used 2 kg, for the manufacture of one product of the second kind − 4 kg of raw materials. Make a production plan that ensures the highest revenue from the sale of products, if you need to produce no more than 40 products of the first kind and no more than 20 products of the second kind, and the selling cost of one product of the first kind is 3000 rubles, and products of the second kind − 2000 rubles.

**Sample the final test ticket (1 semester)**

1. Indefinite integral and its properties.
2. Calculate the limit.
3. The demand function for some goods *D(p)*is given to 82 − 15*p* − 10*p*2 and the offer function of this product *S*(*p)* is given to 2*p*2 − 3*p* − 2, where *p* − the price of goods in rubles.
4. Find the function's monotony intervals. .
5. The productivity of one worker per day is described by the function  where *t* is hours time, 0 ≤ *t* ≤ 8. Determine the output in 5 business days by a team of 7 people.
6. Find the derivative function  at the point , if , , .

**Criteria for a point assessment of various forms of formative assessment**

The criteria for a point assessment of various forms of current performance control are contained in the corresponding guidelines of the Department of Mathematics.

# 7. Mandatory and optional reading list

**7.1 Mandatory reading list:**

1. Высшая математика для экономического бакалавриата: учебник и практикум / Н.Ш. Кремер [и др.]; под ред. Н.Ш. Кремера. – 5-е изд.; перераб. и доп. – М.: Юрайт, 2021. – ЭБС Юрайт.
2. Математика для экономистов и менеджеров [электронный ресурс]: Учебник / под ред. Н.Ш. Кремера. – М.: Кнорус, 2021. ЭБС: book.ru.
3. Математика для экономистов и менеджеров [электронный ресурс]: Практикум: учебное пособие / Н.Ш. Кремер, Б.А. Путко, М.Н. Фридман / под ред. Н.Ш. Кремера. – М.: Кнорус, 2015. ЭБС: book.ru.

**7.2 Optional reading list:**

1. Математика в экономике. Ч.1: Линейная алгебра, аналитическая геометрия и линейное программирование: учебник / А.С. Солодовников [и др.]. – 3-е изд., перераб. и доп. – М.: Финансы и статистика; ИНФРА-М, 2011.
2. Сборник задач по курсу "Математика в экономике". В 3 ч. Ч. 1: Линейная алгебра, аналитическая геометрия и линейное программирование: учебное пособие / под ред. В.А. Бабайцева и В.Б. Гисина. – М.: Финансы и статистика, 2013.
3. Математика в экономике. Ч.2: Математический анализ: учебник / А.С. Солодовников [и др.]. – 3-е изд., перераб. и доп. – М.: Финансы и статистика; Инфра-М, 2011.
4. Сборник задач по курсу "Математика в экономике". В 3 ч. Ч. 2: Математический анализ: учебное пособие / под ред. В.А. Бабайцева и В.Б. Гисина. – М.: Финансы и статистика, 2013.

# 8. List of IT resources, incl. the list of software, information and reference systems (as appropriate)

# 8.1. Software:

Windows, Microsoft Office; Excel

Antivirus ESET Endpoint Security.

**8.2 Databases and information and reference systems**:

Consultant Plus Information and Legal System;

Garant Information and Legal System;

Electronic Encyclopedia: [http://ru.](http://ru.wikipedia.org/wiki/Wiki) [wikipedia.](http://ru.wikipedia.org/wiki/Wiki) [org/wiki/Wiki](http://ru.wikipedia.org/wiki/Wiki)

Comprehensive information disclosure system "СКРИН": [https](file:///C%3A%5C%D0%9D%D0%BE%D0%B2%D0%B0%D1%8F%20%D0%BF%D0%B0%D0%BF%D0%BA%D0%B0%5C%D0%9C%D0%B0%D1%82%D0%B5%D0%BC%D0%B0%D1%82%D0%B8%D0%BA%D0%B0%5Chttps)[://skrin.](https://skrin.ru/) [ru](https://skrin.ru/)

**8.3. Certified software/hardware used for information protection**

 Certified software and hardware information protection is not provided.

1. Skills are described when the Financial University educational standards of the 1st generation and federal state educational standards of higher education “3+” are implemented. [↑](#footnote-ref-1)