**Federal state educational budgetary institution**

**of higher education**

**"FINANCIAL UNIVERSITY**

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

**(Financial University)**

**Department of Mathematics**

Berzin Dmitry Victorovich

**Computer Workshop**

**SYLLABUS**

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

***Field of Study:*** *38.03.02 - "Management"*

**Moscow 2021**

**Federal state educational budgetary institution**

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

Berzin D.V.

**Computer Workshop**

**SYLLABUS**

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

***Field of Study: 38.03.02 - "Management"***

*Recommended by the Scientific Council*

*of the Faculty of Information Technology and Big Data Analysis*

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Discipline "Computer Workshop" is a discipline of the Module of Mathematics and Computer Science of the training direction 38.03.02 "Management" (for all study programs in English).

The syllabus of the discipline indicates its purpose, its position in the structure of the educational program, requirements for the results of mastering the discipline, the content of the program, the topics of practical classes, forms of self-study, assessment tools for current control and intermediate certification, educational, methodological and information support.

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# Name of the discipline

«Computer Workshop».

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

# The discipline provides the necessary tools to form competencies listed below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Competence code** | **Competence** | **Competence development indicators** | **Learning outcomes (skills and knowledge) and indicators that show competence development** |
| **UK-4** | Ability to use applied software in solving professional problems. | 1. Uses the basic methods and means of receiving, presenting, storing, and processing data. | ***Know*** basic methods of receiving, presenting, storing, and processing data    ***Be able to*** apply basic methods of preparation, presentation, storage, and processing data |
| 1. Demonstrates knowledge of professional software packages. | ***Know*** professional software packages    ***Be able to*** apply professional software packages |
| 1. Selects the required application software depending on the problem to be solved. | ***Know*** the application software    ***Be able***to choose the necessary application software depending on the tasks to be solved |
| 1. Uses applied software to solve specific professional problems. | ***Know*** the purpose of the application software    ***Be able to***use applied software to solve specific professional problems |
| **PKN-2** | Ability to apply mathematical methods to solve standard professional problems, to interpret the obtained mathematical results | 1. Demonstrates knowledge of mathematical methods used in management. | ***Know*** the mathematical methods used in management.  ***Be able to*** use mathematical methods used in management. |
| 2. Applies mathematical methods and models to substantiate management decisions. | ***Know***mathematical methods and models to justify management decisions.  ***Be able to***use mathematical methods and models to justify management decisions. |
| 3. Substantially interprets the results obtained using mathematical models. | ***Know the***methods of obtaining results when using mathematical models.  ***Be able to***interpret the results obtained using mathematical models. |

# 3. Place of the discipline in the curriculum

The discipline "Computer Workshop" refers to the group of Mathematics and Informatics disciplines of the direction of training 38.03.02 "Management".

In the process of studying the discipline, the mastering of the basic mathematical concepts necessary for the formation of professional competencies of the graduate of the "Management" direction takes place and the development of tools for solving applied mathematical problems using computational computer technologies. At the same time, students gain experience in applying the studied technologies in practical tasks related to independent search, processing, analysis, assessment, and interpretation of professional information about the functioning of various markets and other economic systems; to carry out accounting, calculation, analytical and control activities in the justification and implementation of managerial, marketing, as well as financial and economic decisions at the micro-level.

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

|  |  |  |  |
| --- | --- | --- | --- |
| Type of work | Total  (in credits and hours) | Semester 1  (in hours) | Semester 2  (in hours) |
| Overall workload | 4/144 | 72 | 72 |
| Classwork | 68 | 34 | 34 |
| Lectures | 0 | 0 | 0 |
| Seminars | *68* | *34* | *34* |
| Self-study | 76 | 38 | 38 |
| Formative assessment |  | Test | Test |
| Summative assessment |  | Exam | Exam |

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

**5.1. Thematic components content**

***Thematic component 1. Introduction to MS Excel.***

MS Excel spreadsheet; concepts of a workbook, worksheet, cell in MS Excel; addressing and formatting of cells; manipulation of cell ranges; data types, data entry, and formulas in cells; selection of a parameter, organization of links.

Built-in MS Excel functions and their application. Elementary functions. Logical functions. Forecasting functions. Function and data search in a certain range (LOOKUP, VLOOKUP, etc.).

 Simple and compound interest. Financial functions (PV, FV, PMT, RATE, NPER), calculation of accruals on deposits and payments on loans, loan repayment plan.

Pivot tables, consolidation, filter, advanced filter, database functions.

***Thematic component 2. Introduction to R and RStudio.***

Installing R and RStudio; description of the console interface; loading and activating R libraries; R data types and variable programming; basic math functions in R; creating custom functions in R and connecting custom libraries; logical constructs and conditional operators in R; ways to read/write data in R in various formats.

***Thematic component 3. Plotting graphs of functions in MS Excel and RStudio.***

Numerical functions, their properties, and methods of setting. Function graph. Complex and inverse functions. Characteristics of functions: evenness and oddness, periodicity, monotony. Limited functions.

***Thematic component 4. Calculation of a limit of a function in MS Excel and RStudio.***

Limit of a numerical sequence. Limit of a function at infinity and a point. One-sided limits. Infinitesimal and Infinitely Large Functions. The first and second remarkable limits.

Continuity of a function at a point. Function breakpoints. Properties of functions that are continuous on a segment. Asymptotes of the graph of a function.

***Thematic component 5. Calculation of a derivative of a function in MS Excel and RStudio.***

Derivative and differential of a function of one variable. The elasticity of function and its application. Higher-order derivatives.

 Local extremum of the function. Convex (concave) functions. Inflection points. The general scheme of the study of a function and the construction of its graph. The largest and smallest values ​​of a continuous function on a segment.

***Thematic component 6. Calculation of definite and improper integrals in MS Excel and RStudio.***

Indefinite integral. Definite integral.  Newton-Leibniz formula. Improper integrals.

***Thematic component 7. Operations with complex numbers and solving algebraic equations***

Complex numbers. Solving algebraic equations. Evaluation of arithmetic expressions.

***Thematic component 8. VBA Application Development Fundamentals***

The basics of the Visual Basic for Application language. Creation of functions. The concept of an object. The main objects of MS Excel. Macros: assignment, creation, and editing. Development of custom dialog boxes.

***Thematic component 9. Operations with matrices in R and MS Excel***

Arithmetic vectors and linear operations on them. Vector space *Rn*. Linear dependence (independence) of the vector system. Basis and dimension of vector space. Coordinates of a vector in the given basis. Dot (inner) product of vectors in *Rn*. The lengths of the vectors and the angle between in *Rn*. Matrix operations. The rank of a matrix. Inverse matrix. Solution of matrix equations AX = B.

Determinants and their properties. Application of determinants: 1) a criterion for non-degeneracy of a square matrix; 2) finding the rank of the matrix; 3) finding the inverse matrix.

***Thematic component 10. Solving a system of linear equations in R and MS Excel***

Solving systems of linear algebraic equations using the Cramer’s method, the inverse matrix, and the Gauss method. Eigenvalues ​​and eigenvectors of square matrices.

***Thematic component 11. Solving applied economic problems in R, Excel***

Finding elasticity and other values ​​in microeconomics; linear programming problems in economics: cost minimization, profit maximization, etc.; transportation problem, assignment problem.

**5.2. Plan of studies**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| №  п/п | **Topics** | **Studies in hours** | | | | | | **Monitoring of progress** |
| **Total** | **Classroom studies** | | | | **Independent studies** |
| Common | Lectures | Seminars | Classes in interactive forms |
| 1 | Introduction to MS Excel | 30 | 14 | – | 14 | 14 | 16 | Classroom independent work. Participation in solving problems in practical classes. Interviews on homework. |
| 2 | Introduction to R and RStudio | 18 | 8 | - | 8 | 8 | 10 |
| 3 | Plotting graphs of functions in R, MS Excel | 8 | 4 | - | 4 | 4 | 4 |
| 4 | Calculating a limit of a function in R, MS Excel | 4 | 2 | - | 2 | 2 | 2 |
| 5 | Finding a derivative in R, MS Excel | 12 | 6 | - | 6 | 6 | 6 |
| 6 | Finding definite and improper integrals in R, MS Excel | 16 | 8 | - | 8 | 8 | 8 |
| 7 | Complex numbers and algebraic equations | 4 | 2 | - | 2 | 2 | 2 |
| 8 | Development of applications in VBA environment | 8 | 4 | - | 4 | 4 | 4 |
| 9 | Matrix operations in R, MS Excel | 18 | 8 | - | 8 | 8 | 10 |
| 10 | Solution of linear systems in R, MS Excel. | 14 | 6 | - | 6 | 6 | 8 |
| 11 | Solution of applied economic tasks in R, MS Excel | 12 | 6 | - | 6 | 6 | 6 |
|  | Overall by discipline | 144 | 68 | - | 68 | 68 | 76 | Tests |
|  | Total in % |  |  |  |  | 100% |  |  |

**5.3. Content of seminars (practical lessons)**

|  |  |  |
| --- | --- | --- |
| **Topics of the discipline** | **A list of questions for discussion at seminars, practical classes, recommended sources from section 8** | **Forms of conducting classes** |
| 1. Introduction to MS Excel | Introduction to MS Excel, entering Data and Formulas into Worksheet Cells.  Organization of links. Elementary functions. Built-in MS Excel functions and their applications. Logical functions. Forecasting functions. (MS Excel).  Search function for data in a certain range (LOOKUP, VLOOKUP, and HLOOKUP). Simple and compound percentages. Financial functions (PV, FV, PMT, RATE, NPER, etc.) (MS Excel).  Pivot tables, consolidation, filter, advanced filter, database functions. (MS Excel).  *Recommended sources: [8.2]*  Forecasting functions (MS Excel). Search function for data in a certain range (LOOKUP, VLOOKUP, HLOOKUP) (MS Excel).  Loan repayment plan.  *Recommended sources: [8.2, 8.4., 8.5 ]* | Solving problems in an interactive form, checking independent work and analyzing errors, completing a class assignment |
| 2. Introduction to R and Rstudio | Installing R and RStudio; description of the console interface; loading and activating R libraries; basic mathematical functions in R.  Creating user-defined functions in R and connecting custom libraries.  *Recommended sources: [8.1]*  Data types in R. Defining vectors (RStudio).  Conditional and loop operators in R (RStudio).  *Recommended sources: [8.1, 8.4., 8.5]* | Solving problems in an interactive form, checking independent work and analyzing errors, completing a class assignment |
| 3. Plotting graphs of functions in R, MS Excel. | Plotting functions in R, MS Excel. Approximate calculation of the behavior of functions near discontinuity points in R, MS Excel. Graphical plotting of oblique asymptotes in R, MS Excel  *Recommended sources: [8.1, 8.2]* | Solving problems in an interactive form, checking independent work and analyzing errors, completing a class assignment |
| 4. Finding a limit of a function in R, MS Excel. | Calculation of a limit of a function in R, MS Excel.  *Recommended sources: [8.1, 8.2]* | Solving problems in an interactive form, checking independent work and analyzing errors, completing a class assignment |
| 5.Finding a derivative of a function in R, MS Excel | Approximate calculation of the derivative of a function at a given point in R, MS Excel.  Monotony and search for local extrema of a function in R, MS Excel. Numerical study of the convexity of a function and search for its inflection points in R, MS Excel.  Complete numerical study of a function in R, MS Excel.  *Recommended sources: [ 8.1, 8.2, 8.4., 8.5 ]* | Solving problems in an interactive form, checking independent work and analyzing errors, completing a class assignment |
| 6. Calculation of definite and improper integral in R, MS Excel | Finding of a definite and improper integral in MS Excel  *Recommended sources: [8.2, 8.4., 8.5]* | Solving problems in an interactive form, checking independent work and analyzing errors, completing a class assignment |
| 7. Operations with complex numbers and the solution of algebraic equations. | Complex numbers. Solving algebraic equations. Calculation of arithmetic expressions (in R, MS Excel ). *Recommended sources: [ 8.1, 8.2, 8.4., 8.5 ]* | Work with educational literature. Solving typical tasks. Analysis of questions on the topic of the lesson. Completing homework for each lesson. |
| 8. Basics of developing applications in the VBA toolbox | Creating macros and functions in VBA.  Creating a form using an example of an economic problem in VBA.  *Recommended sources: [8.2]* | Work with educational literature. Solving typical tasks. Analysis of questions on the topic of the lesson. Completing homework for each lesson. |
| 9.Matrix operations in R, MS Excel | Matrix algebra, import, export of data from R to MS Excel.  Eigenvalues ​​and eigenvectors of matrices. Quadratic Forms (R).  Vectors and actions on them (in R, MS Excel ).  *Recommended sources: [ 8.1, 8.2, 8.4., 8.5 ]* | Work with educational literature. Solving typical tasks. Analysis of questions on the topic of the lesson. Completing homework for each lesson. |
| 10. Solution of linear systems in R, MS Excel. | Solving matrix equations (using the inverse matrix method, Cramer’s rule, Gaussian elimination) (in R, MS Excel).  Economic and mathematical model of input-output balance ("Input-Output" model). Matrix equation (in R, MS Excel).  A graphical method for solving linear programming problems (in R, MS Excel ).  *Recommended sources: [8.1, 8.2, 8.4., 8.5]* | Work with educational literature. Solving typical tasks. Analysis of questions on the topic of the lesson. Completing homework for each lesson. |
| 11. Solution of applied economic tasks in R, MS Excel | Linear programming (Simplex method, production problem, transport problem, and assignment problem) (MS Excel ).  *Recommended sources: [ 8.3, 8.4,8.5 ]* | Work with educational literature. Solving typical tasks. Analysis of questions on the topic of the lesson. Completing homework for each lesson. |

# 6. The list of educational and methodological support for independent work of students

# 6.1. The list of topics assigned to independent studies, forms of extracurricular independent work

|  |  |  |
| --- | --- | --- |
| **Themes** | **List of questions for self-studies** | **Forms of extracurricular independent work** |
| Introduction to MS Excel | |  | | --- | | Logical functions. Forecasting functions.  Calculation of accruals on deposits and payments on loans, loan repayment plan. | | − Solving problems in MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Introduction to R | Data types in R and programming variables, logical structures and conditionals in R; ways to read/write data in R in various formats. | − Solving problems in R;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Plotting functions in R, MS Excel | |  | | --- | | Characteristics of functions: evenness and oddness, periodicity, monotonicity. Limited functions. | | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Calculation of a limit of a function in R, MS Excel | |  | | --- | | Infinitesimal and Infinitely Large Functions. The first and second remarkable limits.  Continuity of a function at a point. Function breakpoints. | | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Calculation of a derivative in R, MS Excel | The elasticity of function and its application.  The largest and smallest values ​​of a continuous function on a segment. | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Calculation of definite and improper integrals in R, Excel | |  | | --- | | Indefinite integral. Newton-Leibnitz formula. | | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Complex numbers and solutions of algebraic equations. | Functions of complex variables. | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Development of applications in the VBA environment. | Visual Basic for Application. Development of user-defined dialog boxes. | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Matrix operations in R, MS Excel | Vector space *Rn*. Linearly dependent vectors. Basis and dimension of vector space. | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Solution of linear systems in R, MS Excel. | |  | | --- | | Eigenvalues and eigenvectors. | | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |
| Solution of applied economic and business problems in R, MS Excel | Finding elasticity and other marginal values ​​in microeconomics. Transportation problem, assignment problem. | − Solving problems in R, MS Excel;  − analysis of questions on the topic of the lesson;  − study of the recommended sources;  - preparation for seminars and practical classes; doing homework;  − fulfillment of tasks of control work |

# 6.2. The list of questions, tasks, topics to prepare for the current control

***Sample questions for tests***

1. How do financial functions work in MS Excel? What sense do they and their arguments make?
2. How to graph a function in MS Excel / R?
3. What is the limit of a numerical sequence, the limit of a function at a point, at infinity? How to calculate the limit using the computational power of MS Excel / R?
4. What is the asymptote of the graph of a function? How to find asymptotes (analytically and in MS Excel / R)?
5. What is the derivative of a function? How do you calculate the derivative using numerical differentiation formulas?
6. What functions are called monotonic? What is the local extremum point of a function? How to examine a function for monotonicity and extrema (analytically and in MS Excel/R)?
7. What functions are called convex and concave? What is the inflection point of a function? How to examine a function for convexity and inflection points (analytically and in MS Excel / R)?
8. What is an indefinite integral, a definite integral, an improper integral? How to calculate the definite/improper integral in R?
9. What are the rules for performing operations on matrices? What is an inverse matrix and for which matrices does it exist? How to perform addition, subtraction, multiplication, transposition, and inverse matrix finding in MS Excel / R?
10. What is a matrix determinant? How to find the determinant of the matrix in Excel / R?
11. What is a system of linear algebraic equations? How many solutions and in what cases can it have? How to solve SLAE in MS Excel / R?
12. How to solve matrix equation like AX = B or XA = B in MS Excel / R?
13. How are linear operations on arithmetic vectors, the dot product of vectors, modulus of a vector, angle between vectors defined? How to perform linear operations, calculate dot product, find the modulus of a vector, find the angle between vectors in MS Excel / R?
14. What are the eigenvalues ​​and eigenvectors of a matrix? How do I find the eigenvalues ​​and eigenvectors of a matrix in R?
15. What is a linear programming problem? How to solve linear programming problems in MS Excel / R?

***Examples of assignments for control works***

**Tasks can be completed both in MS Excel and in RStudio**

***Example 1***

1. Conduct a full study and plot the function.

Find the maximum and minimum value of the function on the segment.

.

1. Conduct a full study and plot the function.

.

1. Using financial functions, determine what the initial value of the deposit should be under the following conditions: the term of the deposit (Nper) is 18 months, the future value of the deposit (FV) is $ 11500; the annual interest rate (Rate) is 12.5%. Additional investments and withdrawals are not made. Interest is compounded quarterly. Answer with two decimal places after the dot.

***Example 2***

1. It is known that the company provides services:

= (3, 7, 1, -5, -1, 1, 0, 1, 5, 1, 6, -5, 1, -2, 4, 0),

=

= (7, 3, -3, 1, -3, 2, -1, -4, 6, 0, 4, 1, -2, -3, 5, 6).

Their implementation requires the corresponding resources *a i, b i, c i*. Moreover, if *a i> 0*, the resource is available, if *a i< 0*, then it is in outsource. For the purpose of multivariate analysis of the company's activities, it is necessary to calculate the following expressions:

а) 4 - 3

b) 6(, )\* + 4\*||\*

c) 4(, )\* - 6(, )\* - 3||\*

Calculate these expressions in either R or MS Excel.

1. Find out how many resources *x 1, x 2,…, x 8* were used in the company to complete the main tasks. It is known that for this it is necessary to solve a system of linear equations. Answer with the accuracy of two decimal places after the dot. Check the result.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *6* | *x1+* | *8* | *x2* | *–* | *x3+* | *8* | *x4* | *–7* | *x5+* | *4* | *x6* | *–2* | *x7+* | *2* | *x8=* | *518,42* |
| *6* | *x1+* | *9* | *x2+* | *7* | *x3+* | *10* | *x4+* | *7* | *x5+* | *6* | *x6+* | *8* | *x7+* | *2* | *x8=* | *1325,72* |
| *6* | *x1* | *–* | *x2+* |  | *x3* | *–6* | *x4+* | *9* | *x5+* | *5* | *x6* | *–5* | *x7+* | *3* | *x8=* | *238,28* |
| *–7* | *x1* |  |  | *–9* | *x3+* |  |  | *5* | *x5+* | *3* | *x6+* | *7* | *x7* | *–* | *x8=* | *–277,38* |
|  |  | *2* | *x2* | *–* | *x3+* | *8* | *x4+* | *6* | *x5+* | *3* | *x6+* | *6* | *x7+* | *7* | *x8=* | *672,06* |
| *–8* | *x1* | *–9* | *x2+* | *4* | *x3+* |  | *x4+* | *4* | *x5+* | *10* | *x6* | *–10* | *x7+* | *6* | |  | | --- | | *x8=* | | *–66,24* |
| *8* | *x1+* |  | *x2* | *–10* | *x3+* | *8* | *x4+* | *4* | *x5* | *–4* | *x6+* |  | *x7* | *–6* | *x8=* | *–335,80* |
| *2* | *x1+* | *10* | *x2* | *–9* | *x3* | *–9* | *x4* | *–9* | *x5+* |  | *x6* | *–7* | *x7+* | *3* | *x8=* | *10,12* |

1. To perform optimal business planning, it is required to solve the matrix equation to find the matrix X according to the given matrices A, B, and the identity matrix E: **Х(В-1)А2=Е.** Check the result.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 8 | 11 | -9 | 8 | 6 | 0 | 5 |  |  |  |  | 1 | 0 | 2 | 8 | 0 | 47 | 10 | 18 |
|  | 9 | -2 | 1 | -2 | 9 | 14 | -18 | 12 |  |  |  |  | 16 | -4 | 2 | 7 | 5 | 13 | 1 | 0 |
|  | 13 | -6 | 11 | 1 | 1 | 18 | 9 | -9 |  |  |  |  | -14 | 2 | -9 | -14 | 1 | -11 | -9 | -17 |
| A= | 15 | -17 | 9 | 18 | -13 | 6 | 3 | 5 |  | ; |  |  | 12 | -15 | -2 | 9 | 17 | 9 | -1 | 6 |
|  | 7 | -5 | -6 | 1 | 14 | -12 | -14 | -10 |  |  | В= | | 15 | 19 | 2 | -49 | 0 | -8 | 12 | 3 |
|  | -3 | -2 | 6 | 17 | 7 | -10 | 9 | -5 |  |  |  |  | 0 | 16 | 16 | 2 | 7 | 3 | -18 | -14 |
|  | 0 | 1 | 17 | 6 | 1 | 13 | -1 | -14 |  |  |  |  | 15 | 14 | -14 | -16 | -8 | -1 | -3 | 1 |
|  | 10 | 15 | 15 | -12 | -2 | 4 | -18 | 16 |  |  |  |  | -11 | 8 | -14 | -19 | 11 | -6 | 17 | -11 |

4. To recover lost passwords for entering the organization portal, it is required to find the eigenvalues ​​and eigenvectors of matrix A with an accuracy of 3 decimal places after the dot. Check the orthogonality of the obtained basis, compounded from eigenvectors.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 35 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | 7 | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | 0 | 0 | 37 | 0 | 0 | 0 | 0 | 0 |
| А= | 0 | 0 | 0 | 26 | 0 | 0 | 0 | 0 |
|  | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 0 |
|  | 0 | 0 | 0 | 0 | 0 | 38 | 0 | 0 |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |

5.  The borrower took a loan from the bank of $3,400,000 for 20 years. The interest rate is 11.75%. The interest is compounded quarterly. How much principal will the client pay in the first 9 years and the 11th year of the period?

6. Optimal business planning requires solving the following linear programming problem:

**Criteria for scoring various forms of progress**

Criteria for scoring various forms of progress are contained in the relevant guidelines of the Department of Mathematics.

# 7. Assessment tools for intermediate certification of students

The list of competencies with indicators of their achievement in the process of mastering the educational program is contained in section 2 "List of planned results of mastering the educational program, indicators of their achievement and planned learning outcomes in the discipline."

**Typical control tasks or other materials required to assess indicators of achievement of competencies, knowledge, and skills**

|  |  |
| --- | --- |
| **Competence code** | **Examples of tasks for assessing indicators of achievement of competencies** |
| UK-4  Ability to use applied software in solving professional problems. | **1. Uses the basic methods and means of receiving, presenting, storing, and processing data.**  **Exercise 1.**  Create a spreadsheet in MS Excel containing data on the euro (EUR) exchange rate for the last month (this information can be found on the official website of Sberbank). Import this data into R as an object of type data.frame  **2. Demonstrates knowledge of professional software packages.**  **Exercise 2.**  Using the financial functions of MS Excel, draw up a plan to repay a loan in the amount of 500 thousand US dollars, taken for 18 months at 4% per annum (interest is compounded monthly) and returned in equal payments at the end of each month.  **3. Selects the required application software depending on the problem to be solved.**  **Exercise 3.**  The vectors are given:  , , .  Calculate    in MS Excel or R.  **4. Uses applied software to solve specific professional problems.**  **Exercise 4.**  There are five tasks: A, B, C, D, E - and five workers: I, II, III, IV, V - to complete them. The table shows the profit that each employee provides when completing each of the tasks.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | I | II | III | IV | V | | A | 18 | 30 | 20 | 18 | 17 | | B | 13 | 18 | 10 | 17 | 13 | | C | 10 | 16 | 11 | 10 | 15 | | D | 19 | 25 | 18 | 17 | 16 | | E | 14 | 18 | 22 | 20 | 8 |   Distribute tasks among employees (one task is performed by one person) so that the total profit from the tasks is the greatest. In the answer, indicate the largest profit found. |
| PKN-2  Ability to apply mathematical methods to solve standard professional problems, to interpret the obtained mathematical results. | **1. Demonstrates knowledge of mathematical methods used in management.**  **Exercise 5.**  Find in official sources (for example, in RBC) information about the cost of a minute of advertising on television channels during the broadcast of the FIFA World Cup over the past 5 years. Analyze the received data. Illustrate the results with a diagram.  **2. Applies mathematical methods and models to substantiate management decisions.**  **Exercise 6.**  The structural trade matrix of the three countries has the form:    ( - is the share of the trade budget that the j-th country spends on the import of goods from the i-th country). Determine the possible budgets of countries in which trade will be balanced (deficit-free) for each of the countries.  **3. Substantially interprets the results obtained using mathematical models.**  **Exercise 7.**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Stock rate in 2020 was: | | | |  | |  | | | | 01.01.2020 | $142 | 01.05.2020 | $154 | | 01.09.2020 | | $166 | | 01.02.2020 | $145 | 01.06.2020 | $155 | | 01.10.2020 | | $166 | | 01.03.2020 | $147 | 01.07.2020 | $161 | | 01.11.2020 | | $169 | | 01.04.2020 | $151 | 01.08.2020 | $165 | | 01.12.2020 | | $172 |   Determine which type of dependence determines the behavior of security more accurately - linear or exponential, and, using the appropriate function, calculate the estimated rate for 03/01/2021 |

***Examples of typical tasks for the test***

***Task 1.*** Using financial functions, determine what the initial value of the deposit should be under the following conditions: the term of the deposit (Nper) is 3.5 years, the future value of the deposit (FV) is $ 21500, the annual interest rate (Rate) is 10%. Additional investments and withdrawals are not made. Interest is calculated on a semi-annual basis. Answer with two decimal places after the dot.

***Task 2.*** The area of ​​the first circle is 760, the area of ​​the second circle is 20. Using the *Goal Seek* tool, determine how many times the radius of the first circle differs from the radius of the second one.

***Task 3.*** Calculate the first derivative of the function at the point x = -1,5. Answer a decimal fraction with an accuracy of 0.001.

***Task 4.*** For the function  find:

1) the ordinate of the point of intersection of the graph with the O y-axis ;

2) a point of a local minimum;

3) local minimum;

4) the point of the local maximum;

5) local maximum.

All answers should be presented as a decimal fraction with an accuracy of 0.001, for example, 1.234

***Task 5.*** The marginal productivity of labor is known: , where *L* – the volume of labor. Find the volume of production, if the volume of labor is *L0*=80. Answer with the accuracy of two decimals after dot.

***Task 6.*** Find the second derivative of the function at the point

x = -2. Answer with a decimal fraction with the accuracy of 0.001

***Task 7.*** Calculate the limit. Answer with a decimal fraction with the accuracy of 0.001

***Task 8.*** Find the absolute maximum and minimum of the function  on the segment [-1;4].

***Task 9.*** The firm decided to take out a loan of $600000 and intends to repay (principal and interest) in equal payments at the end of each month. Determine monthly loan payments for different interest rates and loan maturities (from 5% to 20% and from 1 to 15 years using a lookup table). In the answer, indicate the amount of payment for the 4th year at the interest rate of 12%.

***Task 10.*** Two matrices are given:  ; .

Solve the matrix equation *ВX=А*.

***Task 11.*** The marginal costs of the enterprise are calculated by the formula, where *q* – the volume of production, and fixed costs are *FC*=28. Calculate the total costs for the volume of production *q0*=4,1. Answer with a decimal fraction with the accuracy of 0.01

***Task 12.*** For the matrices

 ; 

calculate (either in MS Excel or in R) matrix equation (and check the result):



***Task 13.*** Find the real and imaginary part of:

***Task 14.*** Reduce the quadratic for to principal axes:

*f = x2+2y2+4z2+6xy-4xz-8yz*

***Task 15.*** Vectors are given:

(0,-4,2,3,1,1,1,0,-5,-2,-1,3)

(-4,-4,0,3,-2,-1,-2,3,3,1,1,5)

(1,5,2,4,3,0,-4,-5,1,2,2,1)

Find the values of expressions:

1.

2.

3.

***Task 16.*** For the manufacture of two types of products A and B, three types of raw materials I, II, III are used. The resources of raw materials, the rates of their consumption per unit of production, and the resulting profit from a unit of production are specified in the table:

|  |  |  |  |
| --- | --- | --- | --- |
| Raw materials | Consumption rates | | Resources |
| А | В |
| I | 1 | 7 | 50 |
| II | 3 | 5 | 50 |
| III | 5 | 2 | 40 |
| Profit | 40 | 20 |  |

Find the optimal plan for the release of products from the condition of maximizing profit.

***Theoretical questions to prepare for the test***

1. MS Еxcel table processor. Entering data and formulas into cells. Formatting. Ranges of cells.

2. Simple and compound interest. Calculation of accruals on deposits and payments on loans, loan repayment plan.

3.  Data Types in R. Creation of user-defined functions.

4.  Numerical functions. Function properties. Function graph.

5.  Limit of a number sequence. Limit of a function at infinity and a point. Limit properties.

6. The first and second remarkable limits.

7. Continuous functions and their properties.

8. Asymptotes of the graph of a function.

9. Derivative and differential of a function of one variable. The elasticity of function and its application.

10. Higher order derivatives and differentials.

11. Monotonic functions. Local extremum of the function. Investigation of the function for monotonicity and extrema.

12. Convex (concave) functions. Inflection points. Investigation of the function for convexity and inflection points.

13. The largest and smallest values ​​of a continuous function on a segment.

14. Indefinite integral. Basic methods of integration: change of variable, integration by parts.

15. Definite integral. Newton-Leibniz formula and its application. Improper integrals.

16. Matrices. Matrix operations. The rank of the matrix. Inverse matrix.

17. Determinant of a matrix. Properties and application of determinants.

18. Systems of linear algebraic equations. Solving systems of linear algebraic equations using Cramer's formulas, matrix inverse, and Gaussian method.

19. The set of solutions to a system of linear algebraic equations. Homogeneous and non-homogeneous systems.

20. Arithmetic vectors and linear operations on them. Vector space.

21. Linear dependence (independence) of the vector system. Basis and dimension of linear space. The coordinates of the vector in the given basis.

22. Dot (inner) product of vectors. The lengths of the vectors and the angle between them in Euclidian space.

23. Eigenvalues ​​and eigenvectors of linear operators (corresponding square matrices).

24. Linear programming problems in economics: cost minimization, profit maximization, etc.; transportation problem, assignment problem.

# 8. The list of basic and additional educational literature necessary for mastering the discipline

# Main literature:

1. Зададаев, С.А. Математика на языке R: учебник / С.А. Зададаев; Финансовый университет при Правительстве РФ, Департамент анализа данных, принятия решений и финансовых технологий. – Москва: Прометей, 2018. – 324 с. – Текст : непосредственный. -То же: URL: Режим доступа : ЭБС: Университетская библиотека онлайн : https://biblioclub.ru/index.php?page=book&id=494941 (дата обращения: 17.05.2021). – ISBN 978-5-907003-59-0. – Текст : электронный.
2. Математика в Excel: учебник для вузов / О.А.Баюк, Д.В.Берзин, А.В.Золотарюк [и др.]; под ред Т. Л. Фомичевой. – Москва: «Прометей», 2019. – 229 с. – Текст : непосредственный

**Additional literature:**

3. Методы оптимальных решений в экономике и финансах. Практикум: учебное пособие / И.А. Александрова [и др.]; под ред. В.М. Гончаренко, В.Ю. Попова. - Москва: Кнорус, 2016. – Текст : непосредственный. – То же. - ЭБС BOOK.ru. - URL: https://www.book.ru/book/919200 (дата обращения: 17.05.2021). - Текст : электронный. (очное обучение).

4. Солодовников А. С. Математика в экономике. Ч.1: Линейная алгебра, аналитическая геометрия и линейное программирование: Учебник для студ. экономич. спец. вузов / А.С.Солодовников, В.А.Бабайцев, А.В.Браилов, И.Г.Шандра - Москва: Финансы и статистика; ИНФРА-М, 2003, 2005, 2006, 2007, 2011. - 384 с.– Текст : непосредственный. - То же. - URL:http://lpvserver190/fulltext/Book/TRUDY%20FA/Mathematics1.pdf (дата обращения: 17.05.2021). - Текст : электронный.

5. Солодовников А. С. Математика в экономике. Ч.2: Математический анализ: учебник для студ. экономич. спец. вузов / А.С. Солодовников, В.А.Бабайцев, А.В.Браилов, И.Г.Шандра. - Москва: Финансы и статистика; Инфра-М, 2003, 2005, 2007, 2011. - 557 с. – Текст : непосредственный.- То же .- 1999.- <http://lpvserver190/fulltext/Book/TRUDY%20FA/Mathematics2.pdf> (дата обращения: 17.05.2021). - Текст : электронный.

**9. The list of Internet resources recommended for studying the discipline**

1. The Portal of the Financial University <http://portal.ufrf.ru/>.
2. Department of Mathematics http://www.fa.ru/org/dep/dm/Pages/Home.aspx
3. Electronic library of the Financial University <http://elib.fa.ru/>
4. Helpful materials on Computer Workshop http://www.zadadaev.com
5. The system BOOK.RU http://www.book.ru
6. Electronic library «Университетская библиотека ОНЛАЙН» http://biblioclub.ru/
7. Electronic library Znanium http://www.znanium.com
8. Electronic library «ЮРАЙТ» https://urait.ru/
9. Electronic library Проспект http://ebs.prospekt.org/books
10. Electronic library «Лань» https://e.lanbook.com/
11. Scientific electronic library eLibrary.ru http://elibrary.ru
12. National electronic library http://нэб.рф/
13. Academic Reference http://ar.cnki.net/ACADREF
14. Bank Focus http://library.fa.ru/resource.asp?id=527
15. Scientific databases EBSCO Publishing http://search.ebscohost.com
16. Electronic library Elsevier http://www.sciencedirect.com
17. Emerald: Management eJournal Portfolio https://www.emerald.com/insight/
18. Electronic library EMIS Global https://www.emis.com/php/companies/overview/index
19. Electronic library MathSciNet https://mathscinet.ams.org/mathscinet/
20. Oxford Scholarship Online https://oxford.universitypressscholarship.com/
21. Electronic library Oxford University Press https://academic.oup.com/journals/
22. ProQuest: Business Ebook Subscription Ebook Central https://search.proquest.com/
23. ProQuest Dissertations & Theses A&I https://search.proquest.com/
24. Data bases RUSLANA of Bureau van Dijk https://ruslana.bvdep.com/
25. Scopus https://www.scopus.com
26. Electronic library Springer: Springer eBooks http://link.springer.com/
27. Web of Science http://apps.webofknowledge.com

# 10. Methodical instructions for students on studying the discipline

Methodological instructions for students on mastering the discipline (a set of recommendations and explanations that allow the student to organize the process of studying the educational material of the discipline) are presented in the *Educational and Organizational Complex for the disciplines of the Department of Mathematics*, posted on the Department of Mathematics page of the website of the Financial University.

# 11. The list of information technologies used in the educational process, including the list of required software and information reference systems:

# 11.1. Licensed software packages:

MS Windows, MS Office;

ESET Endpoint Security Antivirus.

11.2 Modern professional databases and information reference systems:

 Information system "Consultant Plus";

      Information system "Garant";

      Electronic encyclopedia: http://ru.wikipedia.org/

                Information system "SKRIN" - http://www.skrin.ru

11.3. Certified software and hardware information security - not provided

11.4.Microsoft Azure (Cortana Intelligence Suite)

11.5. LensKit (Java support required)

11.6. Python, R, RStudio

# 12. Description of the material and technical instruments necessary for the educational process

To study the discipline, you need a computer. Practical lessons (seminars) are conducted in the computer classes of the Financial University.

Financial University under the Government of the Russian Federation

Department of Mathematics

Dmitry V. Berzin

**Computer Workshop**

**SYLLABUS**

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

***Fields of Study:*** *Management*

***Study Programs:***

*Management, Business Management, Bachelor Business Administration*