Lesya Ukrainka Eastern Europian National University
Faculty of Information Technologies and Mathematics
Department of General Mathematics
and Methods of Teaching Informatics

SYLLABUS

Name of the course: «Mathematics for economists and economic modelling»

I. Description of the course

<table>
<tr><th>Name of indicators</th><th>Field of knowledge, specialty, educational program, educational level</th><th>Characteristics of the course</th></tr>
<tr><td rowspan="2">Full-time education</td><td rowspan="8">Field of knowledge:
29 – International Relations

Specialty: 292 – International Economic Relations

Educational program:
International business

Educational level – Bachelor of International Economic Relations

Professional qualification
– expert in International business and translation (English)

Level of higher education:
Bachelor</td><td>Compulsory</td></tr>
<tr><td>Year of study: I, II</td></tr>
<tr><td rowspan="2">The number of hours / credits 270/9</td><td>Semester: I, II, III</td></tr>
<tr><td>Lectures: 28+10+16=54 hours.</td></tr>
<tr><td rowspan="3">There are no individual tasks</td><td>Practical classes:
40+16+20=76 hours.</td></tr>
<tr><td>Self-study work:
40+40+42=122 hours.</td></tr>
<tr><td>Consultations: 18 hours.</td></tr>
<tr><td>Form of control:
I – exam;
II – test;
III – exam</td></tr>
<tr><td colspan="3">Language of study : English</td></tr>
</table>

II. Information about the teacher

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III. Description of the course

Course Summary

Syllabus of the course «**Mathematics for economists and economic modelling**» is built according to the Educational program – International business; preparation of the experst with the Level of higher education: Bachelor; Field of knowledge: 29 – International Relations and specialty: 292 – International Economic Relations.

The theoretical material of the elements of linear and vector algebra, analytic geometry and mathematical analysis, differential and integral calculus, numerical and functional series, differential equations, probability theory, mathematical statistics**,** economic modelling and financial mathematics is presented in the syllabus of the course. The importance of the course is that in the process of its study the skills and abilities to apply the concepts and facts of mathematics in professional disciplines: international business, international information, basics of economic theories, international monetary and financial relations, information and analytical activities in IER and others.

The aim and the tasks of the course

The aim of the course «Mathematics for economists and economic modelling» is providing the students with fundamental knowledge of mathematics, which allows them to further master special disciplines based on mathematical concepts. Much attention is paid to the development of practical skills in solving professional problems, the ability to apply mathematical methods to study real processes and make optimal decisions.

The main tasks of studying the course «Mathematics for economists and economic modelling» are mastering basic theoretical information and acquiring practical skills and abilities to solve basic types of problems; acquiring the ability to use the acquired knowledge to solve applied problems; mastering the skills of independent work on the material, monitoring and analysis of scientific sources of information and professional literature; gaining skills in analyzing and displaying the results of experimental data processing, computer calculations and other mathematical calculations.

According to the requirements of the educational and professional program, students must:

know :

- elements of matrix calculus and basic methods for solving systems of linear equations;
- vector algebra and methods of analytic geometry;
- methods of differential and integral calculus of functions of one and several variables;
- methods for solving differential equations;
- methods of research of numerical and functional series;
- basic concepts, formulas and theorems of probability theory
- basic concepts of financial mathematics
- basic concepts of economic modelling.

be able :

- to apply the mathematical apparatus in the educational process and research activities;
- to determine the limit of possible applications of mathematical methods;
- to investigate the correctness of problem statement and the existence of solutions.

Learning outcomes (competencies)

As a result of studying the course «**Mathematics for economists and economic modelling**» students must master such competencies**:**

- ability to solve typical and complex specialized tasks and practical problems in professional activity;
- ability to abstract thinking, analysis and synthesis;
- ability to learn and master modern knowledge;
- ability to perform mathematical calculations, estimation and analysis of errors, correct use of units and methods of data presentation;
- ability to apply knowledge and understanding of basic facts in mathematics to solve qualitative and quantitative problems in economics;
- ability to implement modern methods of data analysis;
- skills in the practical application of theoretical information.

Structure of the course

Name of content modules and themes	Total (hours)	Lect. (hour)	Pract. classes (hours)	Self-study work (hours)	Cons. (hours)	*Form of control / Points
I SEMESTER						
Content module 1. Elements of Linear and Vector Algebra						
Theme 1. Matrices and operations on them. Determinants and their main properties. Inverse matrix	8	4	4			self-study work/ 4 points
Theme 2. Main methods of solving systems of linear (simultaneous) equations	12	4	6		2	self-study work/ 4 points
Theme 3. Vectors and operations on them. Scalar, vector and mixed products of vectors and their applications	16	2	4	10		self-study work/ 4 points
Total for content module 1	**36**	**10**	**14**	**10**	**2**	**12 points**
Module test №1						**20 points**
Content module 2. The elements of Analytic Geometry						
Theme 4. Straight line and its equations. The angle between the lines	8	2	4	2		self-study work/ 4 points
Theme 5. Plane and its equations. Straight line in the space	8	2	2	4		self-study work/ 4 points
Theme 6. Second-order curves	12	2	4	4	2	self-study work/ 4 points
Total for content module 2	**28**	**6**	**10**	**10**	**2**	**12 points**
Module test №2						**20 points**
Content module 3. Introduction to mathematical analysis. The elements of Differential Calculus						
Theme 7. Limit of a numerical sequence. Limit of a function	16	2	4	10		self-study work/ 4 points
Theme 8. Continuity of function	4	2	2			self-study work/ 4 points
Theme 9. Derivative of the first and higher orders. Differential. Application of the derivative to the study of functions	15	4	6	5		self-study work/ 4 points
Theme 10. Elements of differential calculus of a function of two variables	15	4	4	5	2	self-study work/ 4 points
Total for content module 3	**50**	**12**	**16**	**20**	**2**	**16 points**
Module test №3						**20 points**
Total for semester: total hours / points	**114**	**28**	**40**	**40**	**6**	**40 points**
Module tests						**60 points**
Form of control	**exam**					**100 points**

II SEMESTER						
Content module 1. The elements of Integral Calculus						
Theme 1. Initial function and indefinite integral. Basic methods of integrating indefinite integrals	20	4	6	10		self-study work/ 10 points
Theme 2. Definite integral and its application. Improper integrals	17	2	2	10	3	self-study work/ 10 points
Total for content module 1	**37**	**6**	**8**	**20**	**3**	**20 points**
Module test №1						**30 points**
Content module 2. Differential Equations. Numerical and Functional Series						
Theme 3. Basic concepts of the theory of differential equations. First-order differential equations: with separable variables; homogeneous; linear	16	2	4	10		self-study work/ 10 points
Theme 4. Numerical and Functional Series	19	2	4	10	3	self-study work/ 10 points
Total for content module 2	**35**	**4**	**8**	**20**	**3**	**20 points**
Module test №2						**30 points**
Total for semester: total hours / points	**72**	**10**	**16**	**40**	**6**	**40 points**
Module tests						**60 points**
Form of control			**test**			**100 points**
III SEMESTER						
Content module 1. Elements of Probability Theory and Mathematical Statistics						
Theme 1. Basic concepts, formulas and theorems of probability theory	16	4	6	6		self-study work/ 8 points
Theme 2. Random quantities, their distribution laws and numerical characteristics	14	4	4	6		self-study work/ 8 points
Theme 3. Elements of mathematical statistics. Linear regression and correlation analysis	21	4	4	10	3	8 points
Total for content module 1	**51**	**12**	**14**	**22**	**3**	**24 points**
Module test №1						**30 points**
Content module 2. Elements of Financial Mathematics and Economic Modelling						
Theme 4. Simple and compound interest. Rent, depreciation, etc	16	2	4	10		self-study work/ 8 points
Тема 5. Concepts and types of economic and mathematical models. Elements of linear programming	17	2	2	10	3	self-study work/ 8 points
Total for content module 2	**33**	**4**	**6**	**20**	**3**	**16 points**
Module test №2						**30 points**
Total for semester: total hours / points	**84**	**16**	**20**	**42**	**6**	**40 points**

Module tests						**60 points**
Form of control	**exam**					**100 points**
Total hours:	**270**	**54**	**76**	**122**	**18**	

Self-study work

№	Theme	Number of hours
I semester		
Content module 1. Elements of Linear and Vector Algebra		
1.	1. Vectors and operations on them. Cartesian rectangular coordinate system. Segment division in this ratio. Projection of the vector on the axis. 2. Scalar product of vectors.	10
Content module 2. The elements of Analytic Geometry		
2.	1. Deviation and distance of a point from a straight line. 2. Intersection of a line with a plane. 3. The angle between the line and the plane. 4. The angle between the planes. 5. Deviation and distance of a point from a plane. 6. Parabola, its form and canonical equation. 7. Polar coordinate system.	10
Content module 3. Introduction to mathematical analysis. The elements of Differential Calculus		
3.	1. The concept of set, operations on sets. The set of real numbers. Module of a real number. Limits of numerical sets. 2. Sequences. Numerical sequence boundary. Properties of convergent sequences. 3. Infinitely small and large numerical sequences, the relationship between them. Properties of infinitesimal sequences. Monotonous sequences. 4. Problems that lead to the concept of derivative. Geometric and mechanical content of the derivative. 5. Application of the derivative to the study of functions. Monotonicity intervals and extremum points. The largest and smallest values of the function on the interval. 6. Conditional extremum of the function of two variables.	20
	Total for the 1 semester:	40
II semester		
Content module 1. The elements of Integral Calculus		
1.	1. The concept of the original. Theorem on the structure of primitives. Indefinite integral and its properties. Table of basic integrals. 2. Integration of trigonometric functions. 3. Problems that lead to the concept of definite integral. Newton-Leibniz formula. Application of a definite integral.	20
Content module 2. Differential Equations. Numerical and Functional Series		
2.	1. Physical problems that lead to differential equations. 2. First-order differential equations with separable variables. 3. Linear differential equations of the second order. The structure of the general solution. Linear homogeneous equations. Fundamental system of solutions of a linear homogeneous equation of the second order.	20
	Total for the 2 semester:	40
	III semester	
Content module 1. Elements of Probability Theory and Mathematical Statistics		

1.	1. Historical aspects of the origin and development of probability theory. The concept of event, classification of events. Basic operations on events, connection with set theory. 2. The most probable number of occurrences of the event in independent trials. Estimation of the probability of deviation of the relative frequency from the constant probability in independent tests. 3. Inequality and Chebyshev's theorem, Lyapunov's theorem. 4. Continuous random variables, their distribution laws and numerical characteristics. 5. A system of two random variables. Conditional laws of distribution of components of system of two casual sizes. 6. Numerical characteristics of the sample. Empirical initial and central moments, asymmetry and excess. 7. Statistical evaluation. Point statistical estimates. Interval statistical estimates.	22
Content module 2. Elements of Financial Mathematics and Economic Modelling		
1.	1. Rent, depreciation. 2. Financial calculations by means of Excel.	20
	Total for the 3 semester:	42
	Total for the course:	**122**

The policy of the course

Course is required for the students of specialty 292 – International Economical Relations. The student is obliged to fully master the knowledge, skills, practical skills and competencies in this discipline.

Attendance policy: attendance at lectures, practical classes, consultations are mandatory. An important reason for absence from classes is an illness, which is confirmed by a certificate from a doctor (sick note). Points for attending lectures are not accrued.

Deadline policy: to prepare for independent, control, individual work, a certain period is provided (of which the teacher notifies students in advance). Any type of work (home, self-study, control, individual), which consists of a violation of deadlines without good reason, is evaluated at a lower score (-1 or 2 points) and the maximum number of points for it is no longer possible.

Academic Integrity Policy: write-offs during independent, test work are prohibited (including using mobile devices). It is possible to use formulas if they are written on a separate sheet.

Final control
I SEMESTER

The form of the final control exam, which takes place in writing and lasts 2 hours. The maximum that a student can get on the exam itself is 60 points. The current control (max - 40 points) is added to the received result and the point for examination is exposed. The exam ticket consists of two theoretical questions and six practical ones. Theoretical questions on topics 1–10 are submitted for the exam.

Exam questions
Elements of linear and vector algebra

1. Matrices and actions on them.
2. Operations on matrices. Properties of operations on matrices.
3. Determinant of the matrix. Basic methods of calculating determinants.
4. Properties of determinants.
5. Minors and algebraic additions.
6. The concept of the inverse matrix. Matrix method for solving systems of linear equations.
7. Solving systems of linear equations by Cramer's formulas.
8. Solving systems of linear equations by the Gaussian method.
9. The concept of rank rank. Basic methods of calculating the rank of the matrix.
10. Theorem of existence of the solution of the system of linear equations and the criterion of definiteness.

11. Scalar and vector quantities. The concept of vector.
12. Operations on the vectors of their properties.
13. Scalar product of two vectors and its properties.
14. Vector product of two vectors and its properties. Vector product in coordinates.
15. Mixed product of three vectors and its properties.
16. Linear dependence and independence of vectors. The concept of basis. Schedule of the vector by basis

Elements of analytical geometry

1. The equation of a line passing through a given point parallel to a given vector.
2. Parametric equation of the line.
3. The equation of a line passing through a given point, or the equation of a beam of lines.
4. Equation of a line with angular coefficient.
5. The equation of a line passing through two points.
6. Equation of a line in segments on axes.
7. The equation of a line passing through a given point perpendicular to a given vector.
8. The normal equation of the line.
9. The general equation of the line.
10. Reduction of the general equation of the line to the normal form.
11. The angle between two lines. Conditions of parallelism and perpendicularity of two lines. Deviation and distance of a point to a straight line.
11. The equation of a plane passing through a given point perpendicular to a given vector.
12. Parametric equation of the plane.
13. General equation of the plane. Investigation of the incomplete plane equation.
14. The equation of a plane passing through three points.
15. The equation of the plane in segments on the axes.
16. Normal plane equation.
17. Reduction of the general equation of the plane to the normal form.
18. The angle between two planes. Conditions of parallelism and perpendicularity of two planes.
19. Deviation and distance of a point from a plane.
20. The equation of a line passing through a given point parallel to a given vector.
21. Parametric equation of the line.
22. A straight line as the intersection of two planes.
23. The angle between two lines. Conditions of parallelism and perpendicularity of two lines in space.
24. The condition of intersection of two lines in space.
25. Intersection of a line with a plane.
26. The angle between a line and a plane. Conditions of parallelism and perpendicularity of a line and a plane.
27. Canonical and general equation of a circle.
28. Ellipse (definition, canonical equation, basic concepts).
29. Hyperbole (definition, canonical equation, basic concepts).
30. Parabola (definition, canonical equation, basic concepts).

Introduction to mathematical analysis

1. The concept of function, ways to specify the function. Area of definition and values of the function.
2. The boundary of a function at a point, the geometric interpretation of the boundary.
3. Unilateral borders.
4. The concept of continuity of a function at a point. Theorem on arithmetic operations on continuous functions.
5. Classification of breakpoints.
6. The concept of derivative. Problems that lead to the concept of derivative. Geometric and mechanical content of the derivative.

7. Differential of a function.
8. Derivatives of higher orders.

9. Disclosure of uncertainties using Lopital rules.
10. Research of functions on monotonicity.
11. Finding the largest and smallest values of the function on the interval.
12. Convexity and concavity of the function, inflection points.
13. Asymptotes of the graph of the function, their types.
14. Algorithm of research of function and construction of its schedule.
15. Functions of two variables. Extreme research.

II SEMESTER

The form of final control is a test, which takes place in writing and lasts 2 hours. The maximum that a student can get on the test itself is 60 points. The current control (max - 40 points) is added to the received result and the point for offset is exposed. On the test, the student receives 6 practical tasks of 10 points each. Tasks that cover the theory on topics 1 - 4 are taken into account.

Elements of integral calculus

1. The concept of the original. Indefinite integral, its properties.
2. Basic methods of integration (method of direct integration, method of variable replacement, integration by parts).
3. Integration of rational functions.
4. Integration of irrational functions.
5. Integration of trigonometric functions.
6. The concept of definite integral, its properties. Newton-Leibniz formula.
7. Basic methods for calculating definite integrals.
8. Application of the definite integral.
9. Improper integrals.

Differential equations

1. The concept of ordinary differential equation.
2. Differential equations with separable variables.
3. Homogeneous differential equations of the first order.
4. Linear differential equations of the first order.
5. Differential Bernoulli equations.
6. Differential equations of higher orders, in which it is possible to reduce the order.
7. Linear homogeneous differential equations of the second order with constant coefficients.

Numerical and functional series

1. Numerical series. Convergence and sum of series. A necessary condition for the convergence of the series.
2. Rows with positive members. Signs of comparison, D'Alembert, Cauchy, integral.
3. Rows with members of different signs. Numerical series, studying them for convergence. Significantly positive series.
4. Functional series. Area of convergence.

III SEMESTER

The form of the final control exam, which takes place in writing and lasts 2 hours. The maximum that a student can get on the exam itself is 60 points. The current control (max - 40 points) is added to the received result and the point for examination is exposed. The exam ticket consists of two theoretical questions and six practical ones. Theoretical questions on topics 1-5 are put to the exam.

Elements of probability theory and mathematical statistics

1. Historical aspects of the origin and development of probability theory.
2. The concept of "test" and "event". Classification of events.
3. Space of elementary events. Relationship between probability theory and set theory.
4. Different definitions of probability (classical, statistical, geometric).
5. Elements of combinatorics (definitions, examples).
6. The rule of sum, the rule of product. Give examples.

7. Basic theorems of probability theory (theorems of addition of probabilities, theorems of multiplication of probabilities).
8. The formula of total probability. Bayesian formula.
9. Bernoulli's theorem. The most probable number of occurrences. Connection of Bernoulli's theorem with Laplace's theorems. Poisson's formula.
10. Random variables, their types. Give examples.
11. The concept of distribution law for discrete random variables.
12. Numerical characteristics of discrete random variables, their properties.
13. Continuous random variables. Their laws of distribution. Give examples
14. Integral distribution function and its properties.
15. Differential distribution function and its properties.
16. Uniform, exponential and normal distribution laws, their characteristics and geometric illustration.
17. Numerical characteristics of continuous random variables.
18. Numerical characteristics of uniform, exponential and normal distribution laws.
19. The concept of statistics and its methods.
20. The general population. The concept of sampling, types of samples.
21. Methods of selection. Give examples.
22. Statistical distribution of the sample.
23. Empirical distribution function.
24. The concept of landfill and histogram.
25. Characteristics of the variation series.
26. Numerical characteristics of the sample (sample mean, sample variance, standard deviation of the sample, median mode, range of variation, coefficient of variation).

Construction of economic and mathematical models of economic processes

27. Conceptual aspects of mathematical modeling of economic processes.
28. Theoretical foundations of mathematical modeling and classification of models.
29. Principles and stages of construction of economic and mathematical models
30. General formulation of the problem of linear programming. Examples of economic problems of linear programming.
31. Model of linear programming problem in expanded and abbreviated form, as well as in matrix and vector forms.
32. Properties of solutions of the linear programming problem. Geometric interpretation of linear programming problems.

Rating scale

Score in points for all types of educational activities	Score
90 – 100	Excellent
82 – 89	Very good
75 – 81	Good
67 – 74	Satisfactorily
60 – 66	Enough
1 – 59	Unsatisfactorily

8. RECOMMENDED BOOKS

1. Bird J. Higher engineering mathematics / John Bird. – Elsevier, 2010. – 705 p.
2. Hefferon J. Linear Algebra / Jim Hefferon. – 507 p. URL: http://joshua.smcvt.edu/linearalgebra
3. Hull J. Options, futures, and other derivatives / J. Hull. – Pearson Education, Prentice Hall, New Jersey, 2006. – 789 p.
4. Астахов, В. М. Теорія ймовірностей і математична статистика : навчальний посібник / В. М. Астахов, Г. С. Буланов, В. О. Паламарчук. – Краматорськ : ДДМА, 2009. – 64 с.
5. Валєєв К. Г. Вища математика. Навчальний посібник: у 2-х ч. / К. Г. Валєєв,

6. Денисюк В. П. Вища математика : підручник : у 2 ч. / В. П. Денисюк, В. К. Репета. – Ч. 1. – К. : НАУ, 2013. – 472 с.
7. Клепко В. Ю. Вища математика в прикладах і задачах: Навчальний посібник. 2-ге видання. / В. Ю., В. Л. Голець.– К. : Центр учбової літератури, 2009. – 594 с.
8. Математика для економістів. Теорія ймовірностей та математична статистика : навчально-методичний посібник / Укл. : Пукальський І. Д., Лусте І. П. – Чернівці: Чернівецький національний університет, 2010. – 96 с.

Approved by the meeting

of the Department of General Mathematics and Methods of Teaching Informatics

protocol № 3, 13 of October 2020

Head of the Department:  Khomyak M.