



MEDICAL UNIVERSITY – PLOVDIV

FACULTY OF PHARMACY

SYLLABUS

IN

ADVANCED MATHEMATICS

Approved by the Department Council, Protocol №17/23.6.2026

Confirmed by the Faculty Council, Protocol №7/15.07.2026

ADVANCED MATHEMATICS

Syllabus

Discipline	Final exam/ semester	According to the Faculty of Pharmacy curriculum of MU-Plovdiv Academic hours				ECTS	Academic hours in semester			
		I semester		II semester						
		Auditorium	Lectures	Practices	Non-auditorium		L	P	L	P
Advanced Mathematics	1	60	15	30	45	3,0	1	2		

DISCIPLINE:

Advanced Mathematics

TYPE OF DISCIPLINE ACCORDING TO THE UNIFORM STATE REQUIREMENTS:

Compulsory

LEVEL OF QUALIFICATION:

Master

FORMS OF TRAINING:

Lectures, seminars, self-training

YEAR OF TRAINING:

First

DURATION OF TRAINING:

One semester

ACADEMIC HOURS:

15 academic hours of lectures, 30 academic hours of seminars

TECHNICAL EQUIPMENT APPLIED IN THE TRAINING:

Multimedia presentations, discussions, demonstrations of methods for solving mathematical problems, solving specific computational problems, solving problems with applications in Pharmacy, preparation for solving theoretical tests.

FORMS OF EVALUATION:

Exam, continuous assessment by 2 colloquia, doing tests, problem solving.

EVALUATION CRITERIA:

Formed to final evaluation of the exam as an average score for each of the three parts of the material as well as the score of the theoretical test.

ASPECTS OF EVALUATION CRITERIA:

True, complete, and accurate solving of the tasks and correctly solving of the tests.

SEMESTER EXAM:

Yes (theoretical test, written examination, and discussion for forming the final mark).

STATE EXAM:

No.

LECTURER:

Professor of Mathematics

DEPARTMENT:

Medical Physics and Biophysics

ANNOTATION

The discipline "Advanced Mathematics" is a fundamental and compulsory academic discipline and provides an opportunity to acquire knowledge and skills necessary for non-specialists in the field of mathematics and useful for the students' specialty. This discipline provides the fundamental quantitative preparation necessary for understanding the subsequent disciplines. Mathematics is not studied as an abstract theory, but as a tool for analytical thinking, modelling processes, interpreting quantitative dependencies, solving practical pharmaceutical problems.

BASIC AIMS OF THE DISCIPLINE

Acquisition of knowledge and skills for applying all methods and tools for solving mathematical problems. The main goal of the educational process in this discipline is to know the basic theoretical facts and master methods for solving problems related to them, such as:

- complex numbers
- operations with matrices
- calculation of determinants
- solving systems of linear equations
- operations with polynomials and factorization
- linear and metric operations with vectors and their application
- types and applications of equations of lines in the plane
- eigenvalues and eigenvectors of a second-order matrix
- investigation of a function of one variable using limits and derivatives

- finding partial derivatives of functions of two variables
- finding extrema of functions of two variables
- solving the main types of indefinite, definite and improper integrals
- solving ordinary differential equations of the first order
- applications of the studied mathematical apparatus in pharmaceutical sciences.

EXPECTED RESULTS

After completion of the course students must have the following knowledge and skills:

- To gain confidence when working on mathematical topics and tasks
- To fill gaps in secondary education in mathematics
- Be familiar with the basic facts of the studied mathematical topics
- Be proficient in proper degree in studied methods for solving the essential tasks
- To know about the main applications of the studied mathematical apparatus in the pharmaceutical sciences
- Be able to use mathematical literature and electronic resources of calculation

LECTURES

PART I. LINEAR ALGEBRA AND ANALYTICAL GEOMETRY

1. Complex numbers **(0.5 h)**
 - 1.1. Definition of complex numbers
 - 1.2. Arithmetic operations with complex numbers
2. Matrices **(0.5 h)**
 - 2.1. Definition of a matrix
 - 2.2. Types of matrices
 - 2.3. Arithmetic operations with matrices
3. Determinants **(1 h)**
 - 3.1. Determinants of the second and third order
 - 3.2. Determinants of the fourth and higher order
 - 3.3. Properties of determinants of arbitrary order.
4. Inverse matrix of a non-degenerate matrix **(1 h)**
 - 4.1. Definition of inverse matrix of a non-degenerate matrix
 - 4.2. Finding inverse matrix, if it exists
 - 4.3. Application to linear matrix equations
5. Systems of linear equations **(1 h)**
 - 5.1. Definition of a system of linear equations
 - 5.2. Universal method for solving systems of linear equations
6. Polynomials **(0.5 h)**
 - 6.1. Definition of polynomials
 - 6.2. Arithmetic operations with polynomials
 - 6.3. Methods for dividing polynomials and their applications
7. Vectors **(0.5 h)**
 - 7.1. Definition of a vector and types of vectors
 - 7.2. Linear operations with vectors
 - 7.3. Cartesian coordinate systems
 - 7.4. Scalar multiplication of vectors
8. Equations of lines in the plane **(0.5 h)**

- 8.1. Types of equations of lines in the plane
- 8.2. Applications of equations of lines in the plane
- 9. Eigenvalues and eigenvectors **(1 h)**
 - 9.1. Applications for a linear operator or its matrix
 - 9.2. Finding the eigenvalues
 - 9.3. Finding the eigenvectors

PART II. INVESTIGATION OF FUNCTION OF ONE AND TWO VARIABLE.

- 10. Functions of one variable **(1 h)**
 - 10.1. Defining a function of one variable
 - 10.2. Types of functions of one variable
 - 10.3. Number series
- 11. Limit and continuity of a function **(1 h)**
 - 11.1. Limit of a function
 - 11.2. Asymptotes of a function
 - 11.3. Continuity of a function
- 12. Derivative and differential of a function **(1 h)**
 - 12.1. Derivative of a function
 - 12.2. Differential of a function
 - 12.3. Derivatives and higher-order differentials
- 13. Application of derivatives **(1 h)**
 - 13.1. Calculation of uncertainties of the type $[0/0]$ or $[\infty/\infty]$
 - 13.2. Approximate representation of a function by a polynomial
 - 13.3. Constancy, monotonicity and extrema of a function
 - 13.4. Convexity, concavity and inflection points of a function
 - 13.5. Studying a function and constructing its graph
- 14. Functions of two variables **(1 h)**
 - 14.1. Defining a function of two variables
 - 14.2. Limit and continuity of a function of two variables
 - 14.3. Partial derivatives of a function of two variables.
 - 14.4. Local extrema of a function of two variables.

PART III. INTEGRATION OF A FUNCTION OF ONE VARIABLE AND AN ORDINARY DIFFERENTIAL EQUATION.

- 15. Indefinite integral **(1 h)**
 - 15.1. Definition of indefinite integral
 - 15.2. Basic integration methods
- 16. Definite integral **(1 h)**
 - 16.1. Definition of definite integral
 - 16.2. Geometric meaning of definite integral
 - 16.3. Basic properties of definite integral
 - 16.4. Intermediate value theorem
 - 16.5. Change of variable theorem
 - 16.6. Applications of definite integral
- 17. Improper integral **(0,5 h)**
 - 17.1. Definition and properties of improper integral
 - 17.2. Applications of improper integral
- 18. Ordinary differential equations of the first order **(0,5 h)**

- 18.1. Basic concepts of ordinary differential equations
- 18.2. Separable ordinary differential equations of the first order
- 18.3. Homogeneous ordinary differential equations of the first order
- 18.4. Linear ordinary differential equations of the first order
- 19. Introduction to mathematical modelling in Pharmacy **(0,5 h)**
 - 18.1. Mathematical models in Medicine and Pharmacy
 - 18.2. Exponential growth and decay models
 - 18.3. Examples of drug concentration modeling

SEMINARS

PART I. LINEAR ALGEBRA AND ANALYTICAL GEOMETRY

- 1. Complex numbers **(1 h)**
 - 1.1. Definition of complex numbers
 - 1.2. Arithmetic operations with complex numbers
- 2. Matrices, determinants, inverse matrix **(2 h)**
 - 2.1. Determinant of the second order
 - 2.2. Determinant of the third order
 - 2.3. Determinant of the fourth and higher order
 - 2.4. Linear operations with matrices. Transpose
 - 2.5. Multiplication of matrices
 - 2.6. Inverse matrix
 - 2.7. Linear matrix equations
- 3. Systems of linear equations **(1 h)**
 - 3.1. Types of systems of linear equations
 - 3.2. Solving by the universal Gauss method
- 4. Polynomials **(1 h)**
 - 4.1. Quotient of polynomials
 - 4.2. Factoring a polynomial
 - 4.3. Factoring a rational expression into elementary fractions
- 5. Vectors and Cartesian coordinate systems **(2 h)**
 - 5.1. Types of vectors
 - 5.2. Linear actions with vectors
 - 5.3. Cartesian coordinate system on an axis
 - 5.4. Cartesian coordinate system in a plane
- 6. Equations of lines in a plane **(2 h)**
 - 6.1. Incidence of a point and a line
 - 6.2. Types of equations of lines
 - 6.3. Lines through a point and along a direction
 - 6.4. Angle between lines
- 7. Eigenvalues, eigenvectors and diagonalization of a matrix **(2 h)**
 - 7.1. Eigenvalues and eigenvectors of a second-order square matrix
 - 7.2. Eigenvalues and eigenvectors of a symmetric matrix
 - 7.3. Diagonalization of a matrix
- 8. Colloquium – Part I **(2 h)**

PART II. STUDY OF FUNCTIONS OF ONE AND TWO VARIABLES

- 9. Types of functions of one variable (1 h)
 - 9.1. Domain of a function
 - 9.2. Monotonicity of a function
 - 9.3. Even and odd functions
 - 9.4. Periodic functions
- 10. Derivatives and differentials of a function (2 h)
 - 10.1. First derivative of a function
 - 10.2. First differential of a function
 - 10.3. Higher-order derivatives of a function
 - 10.4. Higher-order differentials of a function
- 11. Calculating the limit of a function (2 h)
 - 11.1. By transforming a rational expression
 - 11.2. For uncertainties $[0/0]$ or $[\infty/\infty]$
 - 11.3. For uncertainty $[0, \infty]$
 - 11.4. Indeterminate $[\infty - \infty]$
- 12. Extrema and study of a function of one variable (2 h)
 - 12.1. Extrema of a function of one variable
 - 12.2. Convexity and concavity of a function of one variable
 - 12.3. Asymptotes of a function of one variable
 - 12.4. Study of a function of one variable
- 13. Functions of two variables. Local extrema (2 h)
- 14. Colloquium – Part II (2 h)

PART III. INTEGRATION OF A FUNCTION OF ONE VARIABLE AND OF AN ORDINARY DIFFERENTIAL EQUATION

- 15. Indefinite integrals of a function (2 h)
 - 15.1. Basic methods of integration
 - 15.2. Integration of rational functions
- 16. Definite and improper integrals of a function (2 h)
 - 16.1. Definite integrals
 - 16.2. Improper integrals
- 17. Ordinary differential equations of the first order (2 h)
 - 17.1. Separable ordinary differential equations of the first order
 - 17.2. Homogeneous ordinary differential equations of the first order
 - 17.3. Linear ordinary differential equations of the first order

BIBLIOGRAPHY

- 1. **M. Manev, H. Manev.** *Textbook of Advanced Mathematics for pharmaceutical students*, Macros, Plovdiv, 2022. (ISBN 978-954-561-572-6)
- 2. **M. Manev, H. Manev.** *Handbook of Advanced Mathematics for pharmaceutical students*, Macros, Plovdiv, 2022. (ISBN 978-954-561-570-2)

Can be used to some extent and other textbooks, guidebooks and collections of tasks which are addressed to non-mathematical students from different universities.

CONSPECTUS

Part I.

1. Complex numbers. Definition of complex numbers. Arithmetic operations with complex numbers.
2. Definition of a second- and third-order determinant; minor and adjoint quantity of an element of a determinant.
3. Properties of determinants.
4. Matrix of type $m \times n$: definition, types.
5. Operations with matrices: comparing and adding matrices, multiplying a matrix by a number. Properties of these operations.
6. Operations with matrices: multiplying matrices – definition and properties.
7. Inverse matrix of a matrix – definition, existence and finding, application in solving linear matrix equations.
8. System of m linear equations with n unknowns – definition; solution of a system; (in)homogeneous, (in)compatible and (in)determined systems.
9. Methods for solving systems of linear equations: by linear matrix equation and by Gauss' method.
10. Polynomial - definitions (argument, term, degree, coefficients, zero polynomial). Equality between polynomials.
11. Addition, subtraction and multiplication of polynomials. Properties.
12. Division of polynomials - definition. Simple and multiple zero of a polynomial, number of zeros of a polynomial and representation of a polynomial by its zeros.
13. Methods for dividing polynomials: direct division; undetermined coefficients; Horner's. Examples.
14. Vector, directed segment, length of a vector, collinear vectors, zero vector, opposite vector of a given vector. Operations with vectors and properties. Unit vector. Linearly (in)dependent vectors, linear combination of vectors.
15. Cartesian coordinate systems on lines and in the plane. Coordinates of a point, a vector, a directed segment and a linear combination of vectors.
16. Scalar product of vectors – definition, cancellation, properties, applications. Calculation regarding the Cartesian coordinate system in the plane and in space.
17. Equations of lines in the plane: vector parametric, scalar parametric, canonical, through two points, general, Cartesian and cut.
18. Applications of equations of lines: angle between two lines, intersection point of lines.
19. Eigenvalues, eigenvectors and diagonalization of a matrix. Eigenvalues and eigenvectors of a square matrix of the 2nd order. Eigenvalues and eigenvectors of a symmetric matrix. Diagonalization of a matrix.

Part II.

20. Function – definition and ways of specifying. Types of functions – even, odd, periodic, monotone, bounded.
21. Inverse and invertible functions – definition intervals. Irregular number, natural logarithm, exponential function.
22. Limit of a function (left, right), point of condensation. Properties. Some basic limits. Uncertainties. Asymptotes.
23. Continuity of a function – (dis)continuous function at a point.
24. Derivative of a function – definition, geometric and mechanical meaning.
25. Differential of a function. Derivatives and higher-order differentials.
26. L'Hopital's theorems for finding the limit of a function. Application to indeterminacy.
27. Representation of a function using Taylor and Maclaurin formulas. Example of the exponential function.
28. Criteria for constancy and monotonicity of a function.
29. Convexity, concavity and inflection point of a function.
30. Local and absolute extrema of a function.
31. Function of two variables. Complete and partial increments. Limit and continuity of a function of two variables. Partial derivatives of the 1st and 2nd order.
32. Local extrema of a function of two variables.

Part III.

33. Indefinite integral, primitive function, basic rules for integration.
34. Integration by bringing under the differential sign; by substitution.
35. Integration of a rational function; of a trigonometric function.
36. Definite integral – definition and geometric meaning.
37. Basic properties of definite integrals.
38. Basic theorems for definite integrals: for average values; for changing the variable.
39. Improper integral. Applications.
40. Ordinary differential equations of the first order: with separable variables, homogeneous, linear.

Prepared by:

/ Assoc. Prof. H. Manev PhD /