MINISTRY OF HEALTH (UKRAINE)
ODESSA NATIONAL MEDICAL UNIVERSITY

APPROVED
Vice-Rector on Educational and Pedagogic Work
Prof. _____ Shmakova I.P.
" " 2021

WORK PROGRAM ON ACADEMIC DISCIPLINE

"HIGHER MATHEMATICS"

Level of higher education: the second (master's)

Field of knowledge: 22 "Healthcare"

Speciality: 226 « Pharmacy , Industrial Pharmacy»

Educational and professional program: Pharmacy

Odesa 2021 - 2022

The program of studying the discipline **"Higher Mathematics"** was compiled in accor with the educational and vocational program of the second level of higher education on the training of masters in specialty 226 "Pharmacy, Industrial Pharmacy" of ONMedU approved by the Academic Council of ONMedU from 04.06.2020 (Protocol No. 11).

Developer: Associate Professor Zhumatii P.G.

The program was discussed at a meeting of the Department of Biophysics, Informatics and Medical Devices.
Protocol #1 from August 27, 2021
Head of the Department, Professor L.S. Godlevsky

The program was approved at a meeting of the Cycle Subject Commission of Biomedical Science of ONMedU.
Protocol #1 from August 30, 2021
Head of the Cycle Subject Commission of Biomedical Science,
Professor O.L. Appelhans

The program was certified at a meeting of the Central Coordination and Methodological Council of ONMedU on August 30, 2021, Protocol #1.

1. Description of the discipline:

Name of indicators	Characteristics of academic discipline	
	Full-time education	
Total number: Loans – 3,5 Hours – 105 Contents subsectors – 3	Mandatory	
	Year of preparation	1
	Semester	I - 2
	Lecture	20
	Practical	50 hours
	Independent work	35 hours
	Including individual tasks	0
	Summary control form	Diff. test

2. The purpose and objectives of the discipline

Goal: Mastering by a student basic knowledge and competence formation in the field of professional activity, and lay the foundation for students' study of biological physics, physical methods of analysis and metrology in pharmacy, physical and biological chemistry, pharmacokinetics, analytical chemistry, organization and economics in pharmacy, information technologies in pharmacy.

Task:

1.Formation of skills in mathematical research methods in practical situations.

2. Mastering the ability to understand statistical methods necessary for processing research data when solving typical most common problems and using them.

Integral competence

IC. Ability to solve practical problems in professional activities in the field of pharmacy, or in the learning process, which involves implementation of innovations and is characterized by complexity and uncertainty of conditions and requirements.

General competencies

GC1. Ability to act socially responsibly and consciously.
GC2. Ability to apply knowledge in practical situations.
GC3. The desire to preserve the environment.
GC4. Ability to abstract thinking, analysis and synthesis, to learn and be modernly trained.
GC5. Ability to show initiative and entrepreneurship.
GC6. Knowledge and understanding of the subject area and understanding of professional activity.
GC7. Ability to adapt and act in a new situation.
GC8. Ability to communicate in a professional foreign language (mainly English) at a level that ensures effective professional activity.
GC9. Skills in the use of information and communication technologies.
GC10. Ability to choose communication strategy, ability to work in a team and with experts from other fields of knowledge / types of economic activity.
GC11. Ability to assess and ensure the quality of work performed.
GC13. Ability to exercise their rights and responsibilities as a member of society, to realize the values of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.
GC14. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies, use different types and forms physical activity for active recreation and a healthy lifestyle.

Expected learning outcomes. As a result of studying the discipline, the student must:
Know: basics of mathematical analysis and mathematical statistics and use of mathematically specific methods of analysis and metrology in pharmacy, biological and medical physics, physical and biological chemistry, pharmacokinetics, analytical chemistry, organization and economics in pharmacy, mathematical methods of information technologies in pharmacy.
Be able to:
-to replenish knowledge and understanding of the basic mathematical characteristics of medical and biological systems, integrate basic knowledge in physics, chemistry, biology, mathematics, information technology to create the foundation of professional competencies.
-collect, register and analyze data from medical and biological research using appropriate statistical methods and technological means.
-apply quantitative methods in the study of medical and biological processes.
-explain the mathematical basics of functioning and application of modern (electronic) medical devices.
-analyze the composition and mathematical principles of medical devices and equipment.
-carry out mathematical processing of laboratory test results.
Master skills:
-mathematical analysis and mathematical statistics and the use of mathematically specific methods of analysis and metrology in pharmacy, biological and medical physics, mathematical methods of pharmacokinetics.
-mathematical processing results of laboratory tests.
-analysis of the composition and physical principles of the action of medical devices and equipment.

3. Contents of the course

Subsection 1: Mathematical analysis.

Topic 1. Introduction to analysis. Functions.

Introduction to analysis. Functions. Derivative of sum, product, ratio of functions. The derivative of a composite function. Chain rule. Derivatives of higher orders. Application of derivative. Use a derivative to determine monotony intervals, function extremums, curve bulges, and inflection points. Optimization tasks in pharmacy and medicine.

Topic 2. Differential calculus

Differentials of functions. Application of differential. Calculation of the change in the function and its comparison with the differential. Use a differential for a linear approximation of a function and approximate calculations. The use of a differential to find the marginal error of indirect measurements. The function of many variables. Differentiation of functions of many variables. Finding partial derivatives of the first and higher orders. Partial and total differentials. Gradient. The use of a total differential.

Topic 3. Indefinite integral.

Antiderivative. Indefinite integral. Properties of indefinite integral. Table of indefinite integrals. Integration by inspection. Method of substitution. Method of integration by parts. Application of a indefinite integral for solving problems.

Topic 4. Definite integral. Properties of definite integral. Integration by replacing the variable. Newton-Leibniz formula. Improper integrals. Application of a defined integral for solving problems. Multiple integrals. Double integrals. Triple integrals. Fubini's theorem. Line integrals.

Topic 5. Differential equations.

Differential equations. Systems of differential equations. The order differential equations. Homogeneous and inhomogeneous differential equations. Solutions of differential equations. Initial and boundary conditions. Computer uses in differential equations. First order differential equations. Separable differential equations.

Topic 6 Application of differential equation

Linear first-order differential equations. Homogeneous second-order linear differential equations. Nonhomogeneous second-order linear differential equations. Modeling processes by differential equations. Examples: free oscillations, body cooling, diffusion, absorption of light and ionizing radiation, radioactive decay.

Subsection 2. Probability theory.

Topic 7. Random variables

Probability. Basic theorem. Random variables. Analysis of discrete random variables. A probability mass function (pmf), a distribution polygon, a probability function of a discrete random variable. Calculation of distribution characteristics. Measures of central tendency: expectation, median, mode. Measures of dispersion: variance, standard deviation, coefficient of variation.

Topic 8. Probability distribution function (PDF)

Probability distribution function (PDF). PDF for discrete random variable. PDF for continuous random variable. Calculations of probabilities of random values with the distribution function. Find quantiles with the distribution function. Standardized random variables.

Topic 9. Probability density function (pdf).

Probability density function (pdf). Calculation of probabilities of a random value by density function. Calculations of mathematical expectation and variance of a continuous random variable.

Topic 10. Discrete probability distributions.

Discrete probability distributions laws. Bernoulli trials. Binomial probability distribution. Solving problems based on the binomial distribution. Geometric distribution. Negative binomial distribution. Multinomial distribution. Poisson distribution.

Topic 11. Continuous probability distributions.

Continuous probability distributions Uniform distribution. Normal distribution. Gamma distribution. Exponential distribution. Examples for uniform, exponent and normal distribution laws. Chebyshev's inequality and theorem. Law of large numbers. Central-limit theorem.

Topic 12. Sample probability distributions.

Statistical inference. Population and sample. Parameters and statistics. Sample distributions laws. Number of degrees of freedom. Chi-square distribution. Student's *t* distribution. Fisher-Snedeker *F* distribution.

Subsection 3: Mathematical statistics.

Topic 13. Displaying data.

Categorical data. Displaying categorical data. Bar charts. Numerical data. Displaying numerical data. Construction of discrete variation series. Dot plot. Construction of interval variation series. Graphical representation of variation series. Histograms. Frequency polygon. Cumulative frequency. Empirical distribution density function, empirical distribution function. Box plots.

Topic 14. Estimation

Point and interval estimates. Measures of central tendency: mean, median. Measures of dispersion: variance, standard deviation, interquartile range. Calculation of point estimates of mathematical expectation, variance, standard deviation, and standard deviation of the average. Confidence intervals. Confidence interval for the population mean. Confidence interval for the population variance.

Topic 15. Hypothesis testing**.**

Hypothesis testing. Purpose of hypothesis testing. Hypothesis testing steps. Test statistic. Confidence coefficient. Level of significance. Decision rule. Errors of the first and second type. Z and *t* tests for the mean. Comparison of two means. Hypothesis test about the population variance. Comparison of two variances with unknown variances.

Topic 16. Correlation analysis

Correlation analysis. Scatter diagram of bivariate measurement data. Correlation. Covariance. Correlation coefficient. Sample correlation coefficient. Hypothesis test about the population correlation coefficient.

Topic 17. Regression analysis

Regression analysis. Population regression model. Empirical regression line. Linear regression. The method of least squares. Modeling based on the least squares' method. Estimation of the coefficient of determination. Error variance and standard errors of regression estimators. Hypothesis test about the regression relationship.

Topic 18. ANOVA

What is analysis of variance (ANOVA). Statistical model. Factor. Level. Assumptions required to use analysis of variance. Basic concepts of analysis of variance: model of analysis; formulation of hypotheses; experiment plan; criteria for verifying hypotheses; formulation of

conclusion. ANOVA table. Tukey's multiple comparison method. Two-way ANOVA. Reason for conducting a two-way ANOVA. **Differential test.**

4. Structure of academic discipline

Topic	Number of hours			
	Total	Including		
		Lec.	Prac.	IWS
Subsection 1. Mathematical analysis.				
Topic 1. Introduction to analysis. Functions.	7,0	1	4,0	2,0
Topic 2. Differential calculus	4,0	1	2,0	1,0
Topic 3. Indefinite integral	7,0	1	4,0	2,0
Topic 4. Definite integral	4,0	1	2,0	1,0
Topic 5. Differential equations..	7,0	1	4,0	2,0
Topic 6. Application of differential equations.	4,0	1	2,0	1,0
Subsection 2. Probability theory.				
Topic 7. Random variables.	6,0	0	4,0	2,0
Topic 8. Probability distribution function (PDF).	4,0	1	2,0	1,0
Topic 9. Probability density function (pdf).	4,0	1	2,0	1,0
Topic 10. Discrete probability distributions.	4,0	1	2,0	1,0
Topic 11. Continuous probability distributions.	4,0	1	2,0	1,0
Topic 12. Sample probability distributions.	5,0	2	2,0	1,0
Subsection 3: Mathematical statistics.				
Topic 13. Displaying data.	4,0	1	2,0	1,0
Topic 14. Estimation	7,0	1	4,0	2,0
Topic 15. Hypothesis testing.	8,0	2	4,0	2,0
Topic 16. Correlation analysis	4,0	1	2,0	1,0
Topic 17. Regression analysis	7,0	1	4,0	2,0
Topic 18. ANOVA	5,0	2	2,0	1,0
Preparation for differential test	10,0	0	0	10,0
Total hours:	105,0	20	50	35

5. Topics of lectures

№	Topic	Hours
1.	**Differential calculus** Introduction to analysis. Functions. Derivative of sum, product, ratio of functions. The derivative of a composite function. Chain rule. Derivatives of higher orders. Application of derivative. Use a derivative to determine monotony intervals, function extremums, curve bulges, and inflection points. Optimization tasks in pharmacy and medicine. Differentials of functions. Application of differential. Calculation of the change in the function and its	2

	comparison with the differential. Use a differential for a linear approximation of a function and approximate calculations. The use of a differential to find the marginal error of indirect measurements. The function of many variables. Differentiation of functions of many variables. Finding partial derivatives of the first and higher orders. Partial and total differentials. Gradient. The use of a total differential.	
2.	**Integral calculus** Antiderivative. Indefinite integral. Properties of indefinite integral. Table of indefinite integrals. Integration by inspection. Method of substitution. Method of integration by parts. Application of a indefinite integral for solving problems. Definite integral. Properties of definite integral. Integration by replacing the variable. Newton-Leibniz formula. Improper integrals. Application of a defined integral for solving problems. Multiple integrals. Double integrals. Triple integrals. Fubini's theorem. Line integrals.	2
3.	**Differential equations.** Differential equations. Systems of differential equations. The order differential equations. Homogeneous and inhomogeneous differential equations. Solutions of differential equations. Initial and boundary conditions. Computer uses in differential equations. First order differential equations. Separable differential equations. Linear first-order differential equations. Homogeneous second-order linear differential equations. Nonhomogeneous second-order linear differential equations. Modeling processes by differential equations. Examples: free oscillations, body cooling, diffusion, absorption of light and ionizing radiation, radioactive decay.	2
4.	**Random variables** Probability. Basic theorem. Random variables. Analysis of discrete random variables. A probability mass function (pmf), a distribution polygon, a probability function of a discrete random variable. Calculation of distribution characteristics. Measures of central tendency: expectation, median, mode. Measures of dispersion: variance, standard deviation, coefficient of variation. Probability distribution function (PDF). PDF for discrete random variable. PDF for continuous random variable. Calculations of probabilities of random values with the distribution function. Find quantiles with the distribution function. Standardized random variables. Probability density function (pdf). Calculation of probabilities of a random value by density function. Calculations of mathematical expectation and variance of a continuous random variable.	2
5.	**Probability distributions** Discrete probability distributions laws. Bernoulli trials. Binomial probability distribution. Solving problems based on the binomial distribution. Geometric distribution. Negative binomial distribution. Multinomial distribution. Poisson distribution. Continuous probability distributions. Uniform distribution. Normal distribution. Gamma distribution. Exponential distribution. Examples for uniform, exponent and normal distribution laws.	2
6.	**Sample distributions laws. Limit theorems** Statistical inference. Population and sample. Parameters and statistics. Sample distributions laws. Number of degrees of freedom. Chi-square distribution. Student's t distribution. Fisher-Snedeker F distribution. Limit theorems. Chebyshev's inequality. Chebyshev's theorem. Law of large numbers. Central-limit theorem.	2

7.	**Estimation** Categorical data. Displaying categorical data. Bar charts. Numerical data. Displaying numerical data. Construction of discrete variation series. Dot plot. Construction of interval variation series. Graphical representation of variation series. Histograms. Polygon. Cumulative frequency. Empirical probability density function, empirical probability distribution function. Box plots. Point and interval estimates. Measures of central tendency: mean, median. Measures of dispersion: variance, standard deviation, interquartile range. Point estimates of mathematical expectation, variance, standard deviation, and standard deviation of the average. Confidence intervals. Confidence interval for the population mean. Confidence interval for the population variance.	2
8.	**Hypothesis testing** Hypothesis testing. Purpose of hypothesis testing. Hypothesis testing steps. Test statistic. Confidence coefficient. Level of significance. Decision rule. Errors of the first and second type. Z test for the mean. *t* test for the mean. Comparison of two means. Hypothesis test about the population variance. Comparison of two variances with unknown variances.	2
9.	**Correlation and regression analysis** Correlation analysis. Scatter diagram of bivariate measurement data. Correlation. Covariance. Correlation coefficient. Sample correlation coefficient. Hypothesis test about the population correlation coefficient. Regression analysis. Population regression model. Empirical regression line. Linear regression. The method of least squares. Modeling based on the least squares' method. Estimation of the coefficient of determination. Error variance and standard errors of regression estimators. Hypothesis test about the regression relationship.	2
10.	**ANOVA** What is analysis of variance (ANOVA). Statistical model. Factor. Level. Assumptions required to use analysis of variance. Basic concepts of analysis of variance: model of analysis; formulation of hypotheses; experiment plan; criteria for verifying hypotheses; formulation of conclusion. ANOVA table. Tukey's multiple comparison method. Two-way ANOVA. Reason for conducting a two-way ANOVA	2
	TOGETHER	**20**

6. Topics of practical classes

№	Topic	Hours
1.	**Introduction to analysis. Functions**. Introduction to analysis. Functions. Derivative of sum, product, ratio of functions. The derivative of a composite function. Chain rule. Derivatives of higher orders. Application of derivative. Use a derivative to determine monotony intervals, function extremums, curve bulges, and inflection points. Optimization tasks in pharmacy and medicine.	4
2.	**Differential calculus** Differentials of functions. Application of differential. Calculation of the change in the function and its comparison with the differential. Use a differential for a linear approximation of a function and approximate calculations. The use of a differential to find the marginal error of indirect measurements. The function of many variables. Differentiation of functions of many variables. Finding partial derivatives of the first and higher orders. Partial and total differentials. Gradient. The use of a total differential.	2
3.	**Indefinite integral** Integral calculus**.** Antiderivative. Indefinite integral. Properties of indefinite integral. Table of indefinite integrals. Integration by inspection. Method of substitution. Method of integration by parts. Application of a indefinite integral for solving problems.	4
4.	**Definite integral**. Definite integral.Properties of definite integral. Integration by replacing the variable. Newton-Leibniz formula. Improper integrals. Application of a defined integral for solving problems. Multiple integrals. Double integrals. Triple integrals. Fubini's theorem. Line integrals.	2
5	**Differential equations** Differential equations. Systems of differential equations. The order differential equations. Homogeneous and inhomogeneous differential equations. Solutions of differential equations. Initial and boundary conditions. Computer uses in differential equations. First order differential equations. Separable differential equations.	4

6	**Application of differential equations** Linear first-order differential equations. Homogeneous second-order linear differential equations. Nonhomogeneous second-order linear differential equations. Modeling processes by differential equations. Examples: free oscillations, body cooling, diffusion, absorption of light and ionizing radiation, radioactive decay.	2
7.	**Random variables** Probability. Basic theorems. Random variables. Analysis of discrete random variables. A probability mass function (pmf), a distribution polygon, a probability function of a discrete random variable. Calculation of distribution characteristics. Measures of central tendency: expectation, median, mode. Measures of dispersion: variance, standard deviation, coefficient of variation.	4
8.	**Probability distribution function (PDF)**. Probability distribution function (PDF). PDF for discrete random variable. PDF for continuous random variable. Application of probability distribution function for Calculations of probabilities of random values with the distribution function. Find quantiles with the distribution function. Standardized random variables.	2
9.	**Probability density function (pdf)**. Probability density function (pdf).Calculation of probabilities of a random value by density function. Application of probability density function for calculations of mathematical expectation, mode and variance, standard deviation, coefficient of variation of a continuous random variable.	2
10.	**Discrete probability distributions.** Discrete probability distributions laws. Bernoulli trials. Binomial probability distribution. Solving problems based on the binomial distribution. Geometric distribution. Negative binomial distribution. Multinomial distribution. Poisson distribution.	2
11.	**Continuous probability distributions**. Continuous probability distributions. Uniform distribution. Normal distribution. Gamma distribution. Exponential distribution. Examples for uniform, exponent and normal distribution laws. Chebyshev's inequality and theorem. Law of large numbers. Central-limit theorem.	2
12.	**Sample probability distributions** Statistical inference. Population and sample. Parameters and statistics. Sample distributions laws. Number of degrees of freedom. Chi-square distribution. Student's t distribution. Fisher-Snedeker F distribution. Application of sample distributions laws.	2
13.	**Displaying data** Categorical data. Displaying categorical data. Bar charts. Numerical data. Displaying numerical data. Construction of discrete variation series. Dot plot. Construction of interval variation series. Graphical representation of variation series. Histograms. Frequency polygon. Cumulative frequency. Empirical distribution density function, empirical distribution function. Box plots.	2
14.	**Estimation** Point and interval estimates. Measures of central tendency: mean, median. Measures of dispersion: variance, standard deviation, interquartile range. Calculation of point estimates of mathematical expectation, variance, standard deviation, and standard deviation of the average. Confidence intervals. Confidence interval for the population mean. Confidence interval for the population variance.	4
15.	**Hypothesis testing** Hypothesis testing. Purpose of hypothesis testing. Hypothesis testing steps. Test statistic. Confidence coefficient. Level of significance. Decision rule. Errors of the first and second type. Z test for the mean. t test for the mean. Comparison of two	4

	means. Hypothesis test about the population variance. Comparison of two variances with unknown variances.	
16.	**Correlation analysis** Correlation analysis. Scatter diagram of bivariate measurement data. Correlation. Covariance. Correlation coefficient. Sample correlation coefficient. Hypothesis test about the population correlation coefficient.	2
17.	**Regression analysis** Regression analysis. Population regression model. Empirical regression line. Linear regression. The method of least squares. Modeling based on the least squares' method. Estimation of the coefficient of determination. Error variance and standard errors of regression estimators. Hypothesis test about the regression relationship.	4
18.	**ANOVA** What is analysis of variance (ANOVA). Statistical model. Factor. Level. Assumptions required to use analysis of variance. Basic concepts of analysis of variance: model of analysis; formulation of hypotheses; experiment plan; criteria for verifying hypotheses; formulation of conclusion. ANOVA table. Tukey's multiple comparison method. Two-way ANOVA. Reason for conducting a two-way ANOVA. **Differential test.**	2
	Total hours	50

7. Independent work

№	Types of IWS	Hours
1	Preparation for practical classes	25,0
№	Topic	Hours
1.	Introduction to analysis. Functions. Introduction to analysis. Functions. Derivative of sum, product, ratio of functions. The derivative of a composite function. Chain rule. Derivatives of higher orders. Application of derivative. Use a derivative to determine monotony intervals, function extremums, curve bulges, and inflection points. Optimization tasks in pharmacy and medicine.	2
2.	Differential calculus Differentials of functions. Application of differential. Calculation of the change in the function and its comparison with the differential. Use a differential for a linear approximation of a function and approximate calculations. The use of a differential to find the marginal error of indirect measurements. The function of many variables. Differentiation of functions of many variables. Finding partial derivatives of the first and higher orders. Partial and total differentials. Gradient. The use of a total differential.	1
3.	Indefinite integral Integral calculus. Antiderivative. Indefinite integral. Properties of indefinite integral. Table of indefinite integrals. Integration by inspection. Method of substitution. Method of integration by parts. Application of a indefinite integral for solving problems.	2
4.	Definite integral. Definite integral.Properties of definite integral. Integration by replacing the variable. Newton-Leibniz formula. Improper integrals. Application of a defined integral for solving problems. Multiple integrals. Double integrals. Triple integrals. Fubini's theorem. Line integrals.	1

5	Differential equations Differential equations. Systems of differential equations. The order differential equations. Homogeneous and inhomogeneous differential equations. Solutions of differential equations. Initial and boundary conditions. Computer uses in differential equations. First order differential equations. Separable differential equations.	2
6	Application of differential equations Linear first-order differential equations. Homogeneous second-order linear differential equations. Nonhomogeneous second-order linear differential equations. Modeling processes by differential equations. Examples: free oscillations, body cooling, diffusion, absorption of light and ionizing radiation, radioactive decay.	1
7.	Random variables Probability. Basic theorems. Random variables. Analysis of discrete random variables. A probability mass function (pmf), a distribution polygon, a probability function of a discrete random variable. Calculation of distribution characteristics. Measures of central tendency: expectation, median, mode. Measures of dispersion: variance, standard deviation, coefficient of variation.	2
8.	Probability distribution function (PDF). Probability distribution function (PDF). PDF for discrete random variable. PDF for continuous random variable. Application of probability distribution function for Calculations of probabilities of random values with the distribution function. Find quantiles with the distribution function. Standardized random variables.	1
9.	Probability density function (pdf). Probability density function (pdf).Calculation of probabilities of a random value by density function. Application of probability density function for calculations of mathematical expectation, mode and variance, standard deviation, coefficient of variation of a continuous random variable.	1
10.	Discrete probability distributions. Discrete probability distributions laws. Bernoulli trials. Binomial probability distribution. Solving problems based on the binomial distribution. Geometric distribution. Negative binomial distribution. Multinomial distribution. Poisson distribution.	1
11.	Continuous probability distributions. Continuous probability distributions. Uniform distribution. Normal distribution. Gamma distribution. Exponential distribution. Examples for uniform, exponent and normal distribution laws. Chebyshev's inequality and theorem. Law of large numbers. Central-limit theorem.	1
12.	Sample probability distributions Statistical inference. Population and sample. Parameters and statistics. Sample distributions laws. Number of degrees of freedom. Chi-square distribution. Student's t distribution. Fisher-Snedeker F distribution. Application of sample distributions laws.	1
13.	Displaying data Categorical data. Displaying categorical data. Bar charts. Numerical data. Displaying numerical data. Construction of discrete variation series. Dot plot. Construction of interval variation series. Graphical representation of variation series. Histograms. Frequency polygon. Cumulative frequency. Empirical distribution density function, empirical distribution function. Box plots.	1
14.	Estimation	2

	Point and interval estimates. Measures of central tendency: mean, median. Measures of dispersion: variance, standard deviation, interquartile range. Calculation of point estimates of mathematical expectation, variance, standard deviation, and standard deviation of the average. Confidence intervals. Confidence interval for the population mean. Confidence interval for the population variance.	
15.	Hypothesis testing Hypothesis testing. Purpose of hypothesis testing. Hypothesis testing steps. Test statistic. Confidence coefficient. Level of significance. Decision rule. Errors of the first and second type. Z test for the mean. t test for the mean. Comparison of two means. Hypothesis test about the population variance. Comparison of two variances with unknown variances.	2
16.	Correlation analysis Correlation analysis. Scatter diagram of bivariate measurement data. Correlation. Covariance. Correlation coefficient. Sample correlation coefficient. Hypothesis test about the population correlation coefficient.	1
17.	Regression analysis Regression analysis. Population regression model. Empirical regression line. Linear regression. The method of least squares. Modeling based on the least squares' method. Estimation of the coefficient of determination. Error variance and standard errors of regression estimators. Hypothesis test about the regression relationship.	2
18.	ANOVA What is analysis of variance (ANOVA). Statistical model. Factor. Level. Assumptions required to use analysis of variance. Basic concepts of analysis of variance: model of analysis; formulation of hypotheses; experiment plan; criteria for verifying hypotheses; formulation of conclusion. ANOVA table. Tukey's multiple comparison method. Two-way ANOVA. Reason for conducting a two-way ANOVA. Differential test.	1
2	Preparation for differential test	10,0
	Total hours	35

8. Individual tasks

Not provided.

9. Teaching methods

Practice sessions: training exercises and solving situational problems using methods of differential and integral calculus, differential equations, probability theory and mathematical statistics.

Independent work: independent work with the materials of lectures and with the textbook.

10. Control methods and criteria for assessing learning outcomes

Current control: oral questioning, assessment of practical skills in solving problems, evaluation of activity in the classroom.
Final control: differential test.

The structure of the current assessment++:

1. Assessment of theoretic knowledge on the topic of the lesson:
- methods: oral testing, solving problems;
- maximum score – 5, minimum score – 3, unsatisfactory score – 2.
2. Assessment of practical skills on the topic of the lesson:
- methods: assessment of the correctness of problem solving
- maximum score – 5, minimum score – 3, unsatisfactory score – 2;

Criteria of current evaluation in practical class:

«5»	The student is fluent in the material, takes an active part in the discussion and solution and asked, confidently demonstrates practical skills during the solution and asked, expresses his opinion on the topic of the lesson, demonstrates an understanding of the issues of the topic.
«4»	The student knows the material well, participates in discussions and solutions, demonstrates practical skills in solving and interpretetation of results with some mistakes, expresses his opinion on the topic of the lesson.

«3»	The student does not have enough knowledge of the material, participates uncertainly in discussions and solutions and demonstrates practical skills in solving the results with significant errors.
«2»	The student has no knowledge of the material, does not participate in the discussion and solution and does not demonstrate practical skills during problem solving and results interpretetation.

The student is allowed to take the first test in subject if he meets the requirements of the curriculum and if for the current academic activity, he has got at least 3.00 points. Differential test is carried out during the last lesson.

Structure of the **differential test**

Content of the evaluated activity	Quantity
Answering theoretical questions.	2

Differential test criteria for assessing the results of students training:

«5»	Student gets «5» if he systematically worked during the semester, showed during the test versatile and deep knowledge of the program material, is able to successfully perform the tasks provided by the program, learned the content of the main and additional literature, realized the relationship of individual sections of the discipline, their importance for the future profession, showed creative abilities in understanding and using educational and program material, showed the ability to independently update and replenish knowledge; level of competence – high (creative);
«4»	Student gets «4» if he has shown full knowledge of the educational and program material, successfully performs the tasks of the program, learned the main literature recommended by the program, showed a sufficient level of knowledge in the discipline and is able to update them independently and update them in the course of further training and professional activities; level of competence – sufficient (constructive-varied)
«3»	Student gets «3» if he has shown knowledge of the main educational and program material to the extent necessary for further study and subsequent work in the profession, copes with the implementation of the tasks provided by the program, made some mistakes in responses to the test, but has the necessary knowledge to overcome the mistakes made under the guidance of the scientific and pedagogical worker; the level of competence - medium (reproductive)
«2»	Student gets «2» if he did not show sufficient knowledge of the main educational and program material, made fundamental mistakes in responses to the test, cannot use knowledge in further training without the help of the teacher, has not been able to master the skills of independent work; the level of competence is low (receptively productive)

11. Distribution of points received by students

The grade for the discipline is compiled by 50.0% on the assessment for the current success and on 50.0% on the assessment of the response on the differentiated test.

The average score for the discipline is translated into a national assessment and converted into points behind a multi-point scale.

The conversion of the traditional assessment for the discipline into a 200-place is carried out by the information and computing center of the University with the "Contingent" program.

Table of conversion of traditional assessment into multi-point:

National Discipline Score	The amount of points for discipline
«5»	**185 – 200**
«4»	**151 – 184**
«3»	**120 – 150**

Points from the discipline are independently converted into both the ECTS scale and the four-point scale. ECTS scores are not converted to a four-point scale and vice versa. Further accounts are carried out by the information and computing center of the university.

Convertion the traditional grade from the discipline and the amount of points behind the ECTS scale

Grade behind the ECTS scale	Statistics
A	Best 10% of students
B	Next 25% of students
C	Next 30% of students
D	Next 25% of students
E	Next 10% of students

The grade behind the ECTS scale is set by the educational subsection of ONMedU or the dean's office after ranking grades in the discipline among students who study in one course and in one specialty. Ranking of students - citizens of foreign countries is recommended by the decision of the Academic Council to be carried out in one array.

12. The list of questions to the differential test

1. Derivative of a function.
2. Table derivatives.
3. Basic rules for determining derivatives.
4. Use the first derivative to determine the monotony intervals of a function.
5. Use the first derivative to determine the extremes of a function.
6. The use of the second derivative for the study of functions on extreme.
7. The use of the second derivative for the study of functions on the bulge of the function.
8. The use of the second derivative for the study of functions at inflection points.
9. The boundary of the function.
10. Calculating boundaries using Lopithal rules.
11. Differential of a function.
12. Use a differential for a linear approximation of a function and approximate calculations.
13. Functions of several variables. Partial derivatives.
14. Partial differentials of a function of several variables.
15. Total differential.
16. Indirect measurements.
17. Absolute and relative error of measurements.
18. The use of a complete differential to calculate the error of indirect measurements.
19. Indefinite integral.

20. Basic properties of indefinite integral.
21. Table integrals.
22. Integration by inspection.
23. Integration by parts.
24. Cumulative sum. Definite integral.
25. Newton-Leibniz formula.
26. Properties of the definite integral.
27. Area of a flat figure, the work of a variable force.
28. Average of a function.
29. Differential equations.
30. General solution of differential equation.
31. Partial solution of a differential equation.
32. Separable differential equations.
33. Linear differential equations of the first order.
34. Linear homogeneous second-order differential equations.
35. Modeling processes by linear homogeneous first-order differential equations.
36. Differential equations of kinetics of chemical reactions and their solution.
37. Differential equations of reproduction dynamics and their solution.
38. Differential equation of a single-chamber pharmacokinetic model and its solution.
39. A random event. Probability of a random event.
40. Compatible and incompatible random events. Probability add theorem.
41. Dependent and independent random events. Conditional probability.
42. Probability multiplication theorem.
43. The formula of total probability.
44. Bayes theorem and its application.
45. Discrete and continuous random variables.
46. A probability mass function (pmf).
47. Ways to specify the discrete distribution.
48. Condition of rationing of the probability mass function (pmf).
49. Probability distribution function. Properties of the distribution function.
50. Mathematical expectation of a discrete random variable.
51. Variance and standard deviation of a discrete random variable.
52. The law of distribution of continuous random variables.
53. Probability density function and its properties. Mode.
54. Condition of rationing of the probability density function.
55. The mathematical expectation of a continuous random variable.
56. Variance and standard deviation of a continuous random variable.
57. Centered random variables and their numerical characteristics.
58. Standardized random variables and their numerical characteristics.
59. Quantiles.
60. Median, quartiles.
61. Binomial distribution.
62. Negative binomial distribution.
63. Polynomial distribution.
64. Uniform distribution.
65. Exponential distribution.
66. Normal distribution.
67. Density function of normal distribution.
68. Standard normal distribution.
69. The probability of random values entering a given interval under the normal distribution.
70. Chebyshev's inequalities.
71. The law of large numbers in the form of Chebyshev.
72. Application of Chebyshev's theorem in measurement theory.

73. Central boundary theorem.
74. Chi-square distribution
75. T - distribution (Student's distribution).
76. F distribution (Fisher-Snedeker distribution).
77. A population and a sample. Formulation of statistical conclusion.
78. Discrete variation series.
79. Forms of representation of discrete variation series. Dot plot.
80. Interval variation series.
81. Graphical representation of interval variation series: histogram.
82. Graphical representation of interval variation series: cumulates.
83. Empirical distribution function.
84. Empirical density function.
85. Evaluates the sampling population distribution options.
86. Spot estimates according to the sample. Basic requirements for point ratings.
87. Interval evaluation.
88. Estimation. Point estimate of mathematical expectation.
89. Point estimate of variance.
90. Point estimate of statistical deviation.
91. Point estimate of the standard deviation of the average mean.
92. Confidence interval for mathematical expectation.
93. Confidence interval for variance.
94. Marginal absolute error of direct measurements.
95. Marginal absolute error of the set of indirect measurements.
96. Formulation of statistical hypotheses.
97. Verification criterion.
98. One-tail test.
99. Two-tail test.
100. First type errors in hypotheses testing.
101. Confidence coefficient. Level of significance.
102. Second type errors in hypotheses testing.
103. Criterion power and operational characteristics.
104. Method of detection of systematic error of the measurement method. Two-tail test.
105. Method of detection of systematic error of the measurement method. One-tail test.
106. Hypotheses test about the equality of dispersions of two normal sets.
107. Hypotheses test about the better quality of the new measurement method.
108. Hypotheses test about equality of distribution centers of two independent normal samples.
109. Planning an experiment. ANOVA models.
110. One-way ANOVA.
111. Functional and statistical dependence of continuous random variables.
112. Correlation.
113. Theoretical and empirical lines of regression.
114. Construction of empirical regression line.
115. Covariance.
116. Point estimation of covariance.
117. Correlation coefficient and its properties.
118. Point estimation of the correlation coefficient.
119. Analysis of the significance of the line correlation bond.
120. Method of least squares.

13. Methodological support:

Work program of academic discipline
Syllabus of academic discipline

Tutorials:

Zhumatii P.G. Lectures on discipline "Higher mathematics", 2021.

Zhumatii P.G. Mathematical processing of medical and biological data. Tasks. Odessa, 2018, 64p.

Methodical development of practical classes.

14.Recommended literature

Main:

1. Higher Mathematics: A Text-Book for Classical and Engineering Colleges / Edward Howard Griggs. Forgotten Books, 2012.
2. A TextBook of Higher Mathematics: Learning Calculus, Integration and Differentiation in A Simple Way / S.P Thompson. Kindle Edition, 2017
3. Higher Mathematics / M.Mackison, Zeta Maths Publishing, 2021. ISBN-10: 1838141030. ISBN-13: 978-1838141035
4. Introduction to probability and statistics. - William Mendenhall, Brooks/Cole. Cengage learning, 2010

Additional literature

1. First course in differential equations. 10th ed. - Zill D.G., Brooks/Cole. Cengage learning, 2013.
2. Transition to Higher Mathematics: Structure and Proof (Second Edition) / Bob A. Dumas, University of Washington - Seattle Campus, John E. McCarthy, Washington University in St Louis, 2015. ISBN 978-1-941823-03-3.
3. Higher Mathematics, Second Edition / Robert Barclay, Brian Logan, Mike Smith. Hodder Gibson - Boost, 2021. ISBN: 9781398352230