MINISTRY OF HEALTH OF UKRAINE
HIGHER STATE EDUCATIONAL ESTABLISHMENT OF UKRAINE
«BUKOVINIAN STATE MEDICAL UNIVERSITY»

"APPROVE"
Vice-rector for scientific and pedagogical work
Associate Professor I.V. Gerush
"26" 08 2020

STUDENT GUIDE
(SYLLABUS)
of studying the discipline

Higher Mathematics and Statistics

Field of knowledge 22 Healthcare
(code and name of the field of knowledge)

Specialty 226 Pharmacy, industrial pharmacy
(code and name of the specialty)

Educational degree Master
(master, bachelor, junior bachelor)

Educational year 1

Form of study full-time
(full-time, part-time, distance)

Department Biological Physics and Medical Informatics
(name of the department)

Approved at the methodical session of the department of biological physics and medical informatics "11" June 2020 (Protocol №31).

Head of the Department _____ (V.I. Fediv)
(signature)

Approved by the subject methodical commission in medical and biological disciplines of physiological and physicochemical profile "18" June 2020 (Protocol № 11).

Chair of the subject methodical commission _____ (S.S.Tkachuk)
(signature)

Chernivtsi – 2020

1. GENERAL INFORMATION ABOUT SCIENTIFIC AND PEDAGOGICAL WORKERS WHO TEACH THE SUBJECT

Department	Biological Physics and Medical Informatics
Surname, name of scientific and pedagogical staff, scientific degree, academic status	Ivanchuk Mariia – associate professor, PhD, ivanchuk.m@bsmu.edu.ua Kulchynskyi Viktor – assistant, PhD, kulchynsky@bsmu.edu.ua Olar Olena – associate professor, PhD olena.olar@bsmu.edu.ua
Web page of the department on the official website of the university	https://www.bsmu.edu.ua/biologichnoyi-fiziki-ta-medichnoyi-informatiki/
Department website	https://bphmi.bsmu.edu.ua/
E-mail	biophysics@bsmu.edu.ua
Address	Kobylanska str., 42
Contact phone	+38(0372) 524544

2. GENERAL INFORMATION ABOUT THE DISCIPLINE

Status of the discipline	normative
Number of credits	3,5
Total amount of hours	105
Lectures	20
Practical lessons	50
Individual work	35
Type of final control	credit

3. DESCRIPTION OF THE DISCIPLINE (ABSTRACT)

"Higher Mathematics and Statistics" is one of the fundamental general education disciplines that form the theoretical basis for the training of highly qualified specialists in pharmacy.

The study of this discipline forms the basic ideas about the general possibilities of collecting and statistical evaluation of medical and pharmaceutical information, methods of their analysis, as well as the possibility of forecasting on the basis of regression analysis.

4. POLICY OF THE SUBJECT

4.1. ***List of normative documents:***

- Regulations on the organization of the educational process (https://www.bsmu.edu.ua/wp-content/uploads/2020/03/polozhennya-pro-organizacziyu-osvitnogo-proczesu-u-vdnzu-bukovinskij-derzhavnij-medichnij-universitet.pdf);
- Instructions for assessing the educational activities of BSMU students in the implementation of the European credit transfer system of the educational process (https://www.bsmu.edu.ua/wp-content/uploads/2020/03/bdmu-instrukcziya-shhodo-oczinyuvannya-%D1%94kts-2014-3.pdf);
- Regulations on the procedure for reworking missed and uncredited classes (https://www.bsmu.edu.ua/wp-content/uploads/2019/12/reworks.pdf);
- Regulations on the appeal of the results of the final control of knowledge of higher education (https://www.bsmu.edu.ua/wp-content/uploads/2020/07/polozhennya-pro-apelyacziyu-rezultativ-pidsumkovogo-kontrolyu-znan.pdf);
- Codex of Academic Integrity (https://www.bsmu.edu.ua/wp-content/uploads/2019/12/kodeks_academic_faith.pdf);
- Moral and ethical codex of students (https://www.bsmu.edu.ua/wp-content/uploads/2019/12/ethics_code.docx);
- Regulations on the prevention and detection of academic plagiarism (https://www.bsmu.edu.ua/wp-content/uploads/2019/12/antiplagiat-1.pdf);

- Regulations on the procedure and conditions for students to choose elective courses (https://www.bsmu.edu.ua/wp-content/uploads/2020/04/nakaz_polozhennyz_vybirkovi_dyscypliny 2020.pdf);
- Rules of internal labor regulations of the Higher State Educational Institution of Ukraine "Bucovynian State Medical University" (https://www.bsmu.edu.ua/wp-content/uploads/2020/03/17.1-bdmu-kolektivnij-dogovir-dodatok.doc).

4.2. ***Policy on adherence to the principles of academic integrity of higher education students:***

- independent performance of educational tasks of current and final controls without the use of external sources of information;
- cheating during control of knowledge is prohibited;
- independent performance of individual tasks and correct registration of references to sources of information in case of borrowing of ideas, statements, information.

4.3. ***Policy on adherence to the principles and norms of ethics and deontology by higher education students:***

- actions in professional and educational situations from the standpoint of academic integrity and professional ethics and deontology;
- compliance with the rules of internal regulations of the university, to be tolerant, friendly and balanced in communication with students and teachers, medical staff of health care institutions;
- awareness of the importance of examples of human behavior in accordance with the norms of academic integrity and medical ethics.

4.4. ***Attendance policy for higher education students:***

- attendance at all training sessions (lectures, practical (seminar) classes, final modular control) is mandatory for the purpose of current and final assessment of knowledge (except for respectable reasons).

4.5. Deadline policy and completion of missed or uncredited classes by higher education students:

- reworks of missed classes are held according to the schedule of missed or uncredited classes and consultations.

5. PRECISIONS AND POST-REQUIREMENTS OF THE EDUCATIONAL DISCIPLINE (INTERDISCIPLINARY RELATIONS)

List of disciplines, on which the study of academic discipline is based	**List of academic disciplines, for which the basis is laid as a result of studying the discipline**
Secondary school mathematics	Biological physics with physical methods of analysis
	Medical chemistry
	Medical biology
	Drug technology
	Organization of the economy in pharmacy
	Pharmacotherapy with the basics of pharmacokinetics
	Evidence based medicine
	Information technologies in pharmacy

6. PURPOSE AND TASKS OF THE EDDUCATIONAL DISCIPLINE:

6.1. The purpose of studying the discipline is mastering the theory and practice of systematic analysis of pharmaceutical and biological information needed by the future specialist, the formation of an abstract way of thinking.

6.2. The main tasks of studying the discipline are mastering by students of the basic principles and theoretical positions on higher mathematics and statistics; modelling of pharmaceutical

processes by differential equations; studying of 3 types of pharmacokinetic models; description and evaluation of distribution laws for discrete and continuous random variables; processing of pharmaceutical research data by statistical methods

7. **COMPETENCIES, THE FORMATION OF WHICH IS CONTRIBUTED BY THE DISCIPLINE:**

7.*1. Integral competence*: ability to solve typical and complex specialized problems and practical problems in professional pharmaceutical activity using the provisions, theories and methods of basic, chemical, technological, medical-pharmacological and socio-economic sciences; integrate knowledge and solve complex issues, formulate judgments on insufficient or limited information; clearly and unambiguously communicate their conclusions and knowledge, reasonably substantiating them, to professional and non-professional audience.

7.*2. General competencies*:

GC 2. ability to apply knowledge in practical situations;

GC 4. ability to abstract thinking, analysis and synthesis; ability to learn and be modern trained;

GC12:Ability to conduct research at the appropriate level

8. **RESULTS OF STUDYING THE DISCIPLINE.**

As a result of studying the discipline student must:

8.1.Know:

- methods of realization of the acquired knowledge in the decision of practical questions;
- current trends in the industry and analyze them;
- ways of collecting and grouping statistical data;
- methods of mathematical statistics, point and interval estimates of distribution parameters;
- methods and algorithms for statistical testing of hypotheses to study the efficiency of the technological process and the choice of equipment that provides the required standards of production; experiment planning and analysis of variance and correlation;
- statistical methods used in the processing of results obtained in physical, physicochemical and chemical control methods;

8.2.Be able to:

- use professional knowledge to solve practical situations;
- to analyze professional information, make decisions, acquire modern knowledge;
- evaluate the parameters of the distribution, test hypotheses about the type of distribution function or the value of the parameters of the unknown distribution;
- to choose the criteria of consistency of the laws of distribution of the studied traits for the analysis of medical and biological information (statistical testing of hypotheses);
- analyze and interpret the information obtained by statistical methods in these studies (correlation and analysis of variance).

8.3.Demonstrate:

PLO G 2. Ability to apply knowledge of general and professional disciplines in professional activities;

PLO G 4. Ability to use the results of independent search, analysis and synthesis of information from various sources to solve typical problems of professional activity;

PLO G 12. Ability to analyze information obtained as a result of scientific research, summarize, systematize and use it in professional activities.

9. **IINFORMATIONAL SCOPE OF THE DISCIPLINE**

The study of the discipline is given 105 hours, 3.5 ECTS credits, of which 20 hours. - lectures, 50 hours - practical classes, 35 hours - independent work.

Description of each module of the discipline:

Content module 1. **Elements of mathematical analysis and probability theory.**

Topic 1. Differential calculus of a function of one variable.
Definition of derivative. Rules for differentiation of functions. Table of derivatives of basic elementary functions. The physical meaning of the first and second derivatives. Geometric meaning of the derivative. Application of the derivative to determine the intervals of monotonicity and extrema of a function. Application of the second derivative to study the convexity of the curve and find the inflection points. Complete study of the function. Disclosure of uncertainties in finding boundaries according to the Lopital rules. Definition of differential. Geometric content of the differential. Basic formulas and rules of differentiation. Higher order differentials. Application of differential: for approximate calculation of function gain; for an approximate calculation of the value of the function; for linear approximation of the function. Application of a differential to estimate the marginal error of indirect measurements.

Topic 2. Differential calculus of the function of many variables.
Definition of the function of many variables. Boundary function of many variables. Continuity of the function of many variables. Partial derivatives of functions of many variables. Partial and complete differentials function many variables. A sufficient condition for the differentiation of the function of many variables. Application of full differential as a linear approximation of functions. Determination of the marginal error of indirect measurements. Application of full differential for operations with approximate numbers. Investigation of the function of two variables to the extremum. Least squares method.

Topic 3. Integral calculus.
Definition of the indefinite integral. Properties of the indefinite integral. Table of basic integrals. Direct integration. Integration by variable replacement method. Method of integration by parts. Definition of a definite integral. Newton-Leibniz formula. Properties of a definite integral. Defined integral with changing integration boundaries. Improper integrals. Calculating the area of a flat figure. The path with uneven movement. Work of variable force. The product of a chemical reaction. Application of the mean value theorem.

Topic 4. Differential equations.
Basic concepts of the theory of differential equations. General consideration of first order differential equations. Differential equations with separated and separated variables. Linear differential equations of the first order. General consideration of second-order differential equations. Second-order differential equations, which are solved by lowering the order. Linear homogeneous differential equations of the second order with constant coefficients. Modeling of processes by a linear homogeneous differential equation of the first order: radioactive decay, the law of absorption of Booger's light and the law of absorption of ionizing radiation, the law of cooling of a body; the law of reproduction of bacteria; the law of dissolution of the drug substance from the tablet. Kinetics of chemical reactions. First-order chemical reactions. Second-order chemical reactions. Pharmacokinetic models. Single-chamber linear pharmacokinetic model

Topic 5. Probabilities of random events.
Analysis of random variables. The subject of probability theory. Statistical definition of the probability of a random event. The classic definition of the probability of random events. Compatible and incompatible random events. Selective space of random events. Operations on random events. Probability function. Conditional probability. Dependent and independent random events. Probability multiplication theorems. Probability addition theorems. Random variable. The law of distribution of a random variable. Ways to set the distribution law for discrete random variables: distribution series; distribution polygon; probability function. Random magnitude distribution function. Properties of the distribution function. Quantiles. Function of density of

distribution of a continuous random variable. Properties of the distribution density function. Fashion. Median. Mathematical hope. Properties of mathematical expectation. Dispersion and standard deviation. Dispersion properties. Centered and normalized random variables.

Content module 2. **Theory of statistical research in pharmacy**

Topic 6. Basic laws of distribution of random variables.
Bernoulli test scheme. Binomial distribution law and its characteristics. Bernoulli's formula. Approximation formulas of the binomial distribution probability function: local and integral Muavra-Laplace formulas. Poisson's distribution law. Characteristics of the Poisson distribution. Poisson distribution as an approximation of the binomial distribution law for rare events. Uniform distribution and its characteristics. Exponential distribution. Density function and exponential distribution function. Characteristics of the exponential distribution. Normal distribution law. Study of the Gaussian curve. Characteristics of normal distribution. Standard normal distribution. Density function and standard normal distribution function. Tables of standard normal distribution.

Topic 7. Boundary laws of probability theory.
Laws of distribution of sampling statistics. The set of independent random variables. The average random variable and its characteristics. Chebyshev's inequality: the first form. Chebyshev's inequality: the second form. The law of large numbers in the form of Chebyshev. Application of Chebyshev's theorem in the theory of measurements. Central limit theorem. Applied value of the central limit theorem. Sampling of random variables. Sampling statistics. $|^2$ - distribution (Pearson distribution). Pearson's distribution table. Sampling statistics that are subject to the $|^2$ distribution. t is the distribution (Student's distribution). Student's distribution tables. Sample statistics that are subject to the Student's distribution. F - distribution (Fisher-Snedekor distribution). Fisher-Snedekor distribution tables. Sampling statistics that are subject to the Fisher-Snedekor distribution.

Topic 8. Analysis of variation series.
Population and sample. Methodology of statistical conclusion. Discrete variation series. Graphical representation of a discrete variation series. Empirical distribution function for a discrete feature. Interval variational series. Construction of histograms. Empirical distribution density function. Empirical distribution function of a continuous feature. Graphical representation of the empirical density function and the empirical distribution function of the studied feature.

Topic 9. Statistical testing of hypotheses.
Basic principles of statistical testing of hypotheses: formulation of hypotheses; verification criterion; Errors of the first and second kind; formulation of statistical conclusion. Checking the method of analysis for systematic error. Comparison of a new method of analysis with the standard reproducibility. The influence of the factor on the displacement of the centre of distribution of the feature. General scheme of hypothesis testing. Testing the statistical hypothesis about the equality of variances of two normal sets. Testing the hypothesis of equality of distribution centres of two independent normal sets. Testing the hypothesis of equality of distribution centres of two conjugate sets.

Topic 10. Analysis of variance, correlation and regression analysis.
Basic concepts of analysis of variance. One-way analysis of variance for parametric model. The concept of analysis of variance of multifactorial experimental plans. Statistical relationship between continuous features. Correlation dependence. Regression equation. Empirical regression line. Correlation coefficient. Estimation of correlation coefficient and analysis of its significance. Modelling of regression equation. Linear regression model. Analysis of the significance of a linear correlation based on analysis of variance. Curvilinear regression models.

10. STRUCTURE OF EDUCATIONAL DISCIPLINE

Names of content modules and topics	Amount of hours				
	Total	including			
		Classroom		Independent students' work	Individual work
		Lections	Practicals		
1	2	3	4	5	6
Content module 1. **Elements of mathematical analysis and probability theory.**					
Differential calculus of a function of one variable	**8**	1	2		5
Differential calculus of the function of many variables	**5**	1	2		2
Integral calculus	**11**	2	6		3
Differential equations	**18**	2	10		6
Probabilities of random events	**14**	4	6		4
Total by content module 1	**4**		2		2
Content module 2. **Processing and analyzing of biological data. Medical knowledge and decision making in medicine.**					
Basic laws of distribution of random variables	**8**	2	4		2
Boundary laws of probability theory	**3**	-	-		3
Analysis of variation series	**10**	2	6		2
Statistical testing of hypotheses	**7**	2	4		1
Analysis of variance, correlation and regression analysis	**13**	4	6		3
Test	**4**		2		2
Total by content module 2	**45**	**10**	**22**		**13**
TOTAL	**105**	**20**	**50**		**35**

11. **THEMATIC PLAN OF LECTURES**

№	Name of topic	Amount of hours
1	**Differential calculus.** Derivative function. Function differential. Application of differential. Function of many variables. Partial derivative. Partial and full differentials. Application of full differential.	2
2	**Integral calculus.** Indefinite integral. Properties of the indefinite integral. Defined integral. Newton-Leibniz formula. Properties of a definite integral. Improper integrals.	2
3	**Differential equations.** Basic concepts of the theory of differential equations. Modeling by differential equations of processes in physics, chemistry, biology and medicine.	2
4	**Probabilities of random events**. Adventure. Statistical and classical definition of probability of a random event. Theoretical-multiple consideration of random events. Conditional probability. Probability multiplication theorems. Probability addition theorems.	2
5	**Analysis of random variables**. Random variable. Ways to set the distribution law for discrete random variables. Distribution function. Distribution density function. Distribution characteristics: mathematical expectation, variance, standard deviation.	2
6	**Laws of distribution of random variables**. Binomial distribution law. Muavra-Laplace approximation formulas. Poisson distribution. Normal distribution law.	2

7	**Analysis of variation series**. General and sample population. Discrete variation series. Interval variation series. Empirical distribution density function. Empirical distribution function. Point and interval estimates of the characteristics of the studied trait.	2
8	**Statistical testing of hypotheses**. Formulation of hypotheses. Verification criterion. Errors of the first and second kind. Formulation of statistical conclusion. General consideration of testing hypotheses about equality of parameters of independent normal sets.	2
9	**Correlation and regression analysis**. Correlation dependence. Regression equation. Empirical regression line. Estimation of the correlation coefficient according to the sample data and analysis of its significance.	2
10	**Analysis of variance**. Basic concepts of analysis of variance: analysis model; formulation of hypotheses; experiment plan; hypothesis testing criteria; formulation of the conclusion. One-way analysis of variance for parametric model.	2
	Total	**10**

12. **THEMATIC PLAN OF PRACTICAL CLASSES**

№	Name of topic	Amount of hours
1	Derivative and differential of functions of one variable. Derivatives of higher orders	2
2	Functions of many variables. Partial derivatives. Full differential	2
3	Indefinite integral. Direct integration and substitution.	2
4	Integration in parts	2
5	Defined integral ..	2
6	Differential equations with separable variables	2
7	Linear differential equations of the first order	2
8	Linear differential equations of the second order with constant coefficients	2
9	Modeling of processes by a linear homogeneous first-order differential equation.	2
10	Pharmacokinetic models.	2
11	Elements of probability theory. Random events. Probabilities of random events. Dependent and independent random events. Conditional probability. Probability addition and multiplication theorems	2
12	Discrete random variables and their characteristics	2
13	Continuous random variables and their characteristics	2
14	Test	2
15	Laws of distribution of discrete random variables	2
16	Laws of distribution of continuous random variables	2
17	Statistical distribution of the sample. Landfill, histogram	2
18	Estimation of parameters of the general population according to its sample	2
19	Accuracy and reliability of assessment. Confidence interval	2
20	Statistical testing of hypotheses. Lesson 1	2
21	Statistical testing of hypotheses. Lesson 2	2
22	Elements of correlation analysis. Finding the linear correlation coefficient. Checking the significance of the sample correlation coefficient.	2
23	Calculation of direct regressions.	2
24	Elements of analysis of variance	2
25	Test	2
	Total	**50**

13. **THEMATIC PLAN OF INDIVIDUAL WORK**

№	Name of topic	Amount of hours
1	**Differential calculus of a function of one variable.**	5

	Boundary of functions. Infinitely small and infinitely large. Basic theorems on boundaries. Continuity of functions Research of functions by means of differential calculus	
2	**Differential calculus of the function of many variables** Application of differential functions for approximate calculations. Application of differential functions to calculate errors	2
3	**Integral calculus** Master the ability to integrate indefinite integrals by replacing variables and parts Master the ability to calculate definite integrals by the Newton - Leibniz formula.	3
4	**Differential equations** Master the ability to solve differential equations Modeling of medical and biological processes using differential equations	6
5	**Probabilities of random events. Analysis of random variables.** Master the ability to find the probabilities of random events. Master the ability to find numerical characteristics of discrete and continuous random variables.	4
6	Preparation for the test	2
7	**Basic laws of distribution of random variables.** Be able to apply the laws of distribution of discrete random variables. Be able to apply the laws of distribution of continuous random variables.	2
8	**Boundary laws of probability theory. Laws of distribution of statistics samples.** Master the central limit theorem and local and integral Laplace theorems. Chebyshev's law of large numbers. Lyapunov's theorem Master the distributions of random variables χ^2, Fischer-Snedekor.	3
9	**Analysis of variation series.** To master the ability to evaluate the parameters of the general population according to its sample Master the ability to find confidence intervals for the average	2
10	**Statistical testing of hypotheses.** Master the ability to test statistical hypotheses Master the ability to find the coefficient of linear correlation and check its significance	1
11	**Analysis of variance, correlation and regression analysis.** Master the ability to calculate direct regressions Master the ability to perform one-way analysis of variance	3
12	Preparation for the test	2
	Total	**35**

14. **LIST OF INDIVIDUAL TASKS**

Not provided.

15. **LIST OF THEORETICAL TASKS TO THE FINAL MODULE CONTROL**

Not provided.

16. **LIST OF PRACTICAL SKILLS AND TASKS TO THE FINAL MODULE CONTROL**

Not provided.

17. **METHODS AND FORMS OF IMPLEMENTATION OF THE CONTROL**

Current control is based on the control of theoretical knowledge, skills and abilities.

Forms of current control:

1. Oral interview (frontal, individual, combined).

2. Practical checking of the formed professional skills (check of individual tasks which are carried out by the student on the computer).

The student's independent work is assessed in practical classes and is part of the final assessment of the student.

Form of final control of learning success: credit.

At the last thematic lesson on the subject after the analysis of the lesson, the teacher of the study group announces the amount of points that each student of the group scored on the results of current control.

18. EVALUATION OF THE LEVEL OF STUDENT TRAINING IN THE DISCIPLINE

The results of the tests are evaluated on a two-point scale: "credited", "not credited".

The student receives a grade of "credited" if he has completed all types of work provided by the working curriculum in the discipline, attended all classes - lectures, practical (seminar), defined

by the thematic plan of the discipline (if there are gaps - worked them in time), typed the total number of points in the study of the discipline is not less than 120.

The student receives a grade of "not credited" if the student has unfinished absences from classes (practical, seminar and lectures) and the number of points for the current control is less than the minimum.

Distribution of points assigned to students

During the assessment of mastering each topic of the module, the student is graded on a 4-point (traditional) scale and on a 200-point scale using the accepted and approved assessment criteria for the relevant discipline. This takes into account all types of work provided by the methodological development for the study of the topic. The student must receive a grade on each topic.

Points for individual student performance are also added to the current performance. Individual work (IP) is performed electronically and submitted for verification until the last lesson of the discipline. Full reflection of the tasks and the defense of the work allows the student to get the maximum possible score allocated for individual work.

The final score for current activities is recognized as the arithmetic sum of scores for each lesson and for individual work.

Number of module number of study hours / number of credits ECTS	Number of content modules, their numbers	Number of practical classes	Number of topics evaluated	Conversion into point of the traditional scale					Minimum score *
				Traditional scale				Scores for individual task	
				"5"	**"4"**	**"3"**	**"2"**		
Module 1 105/3,5	2 (№№1-2)	25	20	10	8	6	0	0	120

Minimum number of points for studying the discipline:
6 points x 20 topics = 120 points
Maximum number of points for studying the discipline:
10 points x 20 topics = 200 points

19. RECOMMENDED LITERATURE

19.1 Basic

1. Jay Abramson et al. *Precalculus*, 2017, 1156 p., https://d3bxy9euw4e147.cloudfront.net/oscms-prodcms/media/documents/Precalculus-OP_9wwF7YT.pdf
2. Edwin J. Herman, Gilbert Strang et al. *Calculus Volume 1*, 2020, 875 p., https://d3bxy9euw4e147.cloudfront.net/oscms-prodcms/media/documents/Calculus_Volume_1_-_WEB_68M1Z5W.pdf
3. Edwin J. Herman, Gilbert Strang et al. *Calculus Volume 2*, 2020, 829 p., https://d3bxy9euw4e147.cloudfront.net/oscms-prodcms/media/documents/CalculusVolume2-OP.pdf
4. Edwin J. Herman, Gilbert Strang et al. *Calculus Volume 3*, 2020, 1023 p., https://d3bxy9euw4e147.cloudfront.net/oscms-prodcms/media/documents/CalculusVolume3-OP_mktoy8b.pdf
5. Barbara Illowsky, Susan Dean et al. *Introductory Statistics*, 2020, https://d3bxy9euw4e147.cloudfront.net/oscms-prodcms/media/documents/IntroductoryStatistics-OP_i6tAI7e.pdf

19.2. Auxillary

1. Elias Zakon *Mathematical Analysis I*, 2017, 367 p., http://www.trillia.com/dA/zakon-analysisI-a4-one.pdf
2. Elias Zakon *Mathematical Analysis II, 2017, 436 p.* http://www.trillia.com/dA/zakon-analysisII-a4-one.pdf
3. Russell A. Poldrack *Statistical Thinking for the 21st Century*, 2019, https://statsthinking21.github.io/statsthinking21-core-site/
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman *The Elements of Statistical Learning*, Springer, 2017, 764 p., https://web.stanford.edu/~hastie/Papers/ESLII.pdf
5. Alexander Holmes, Barbara Illowsky, Susan Dean et al. *Introductory Business Statistics*, 2018, 631 p., https://d3bxy9euw4e147.cloudfront.net/oscms-prodcms/media/documents/IntroductoryBusinessStatistics-OP.pdf

19.3 Information resources

1. http://www.bymath.com/ (The Mathematical Web High School)
2. https://www.socscistatistics.com (Social Science Statistics)
3. https://www.statisticshowto.com/ (Statistics How To)

20. COMPILERS OF THE STUDENT HANDBOOK (SYLLABUS)

1. Mykytiuk Orysia – associate professor, PhD,
2. Ivanchuk Mariia – associate professor, PhD