Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Geoengineering

SCIENTIFIC FUNDAMENTALS OF MATHEMATICAL PROCESSING OF ENGINEERING RESEARCH

Work program of the discipline (Syllabus)

Details of the discipline

Level of higher education	***First (bachelor's)***
Branch of knowledge	*18 Production and technology*
Specialty	*184 Mining*
Educational program	*Geoengineering*
Discipline status	*Selective*
Form of study	*full-time / full-time / distance / mixed*
Year of preparation, semester	*3rd year, spring semester*
The scope of discipline	*5 credits / 150 hours (lectures - 9 hours, practical - 5 hours, individual lessons - 40 hours, independent work - 96 hours)*
Semester control / control measures	*Credit, modular test*
Timetable	*rozklad.kpi.ua/*
Language of instruction	*Ukrainian*
Information about course leader / teachers	Lecturer: Doctor of Technical Sciences, Zuievska Natalia Valeriyivna, (+38) 0509821770, zuevska@i.ua Practical: Doctor of Technical Sciences, Zuievska Natalia Valeriyivna, (+38) 0509821770, zuevska@i.ua
Course placement	https://classroom.google.com/c/MjUyNjU2ODI4OTM3?cjc=3tdbc2y

Curriculum of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

Engineering surveys for construction are a type of scientific and technical activity (according to the Law of Ukraine "On scientific and scientific and technical activity"), which provides study of natural and man-made conditions of territories (sites) of construction objects, development of forecasts of interaction of construction objects with environment, development of all types of projects (including engineering preparation of territories, protection of territories and objects from dangerous processes).

The purpose *Teaching the discipline "Scientific principles of mathematical processing of engineering research" is to provide students with theoretical knowledge that allows them to use the methods of mathematical statistics in order to apply them to process the results of physical experiment and choose the best model.*

The subject *the study of the discipline is the analysis of errors in the measurement of physical quantities, statistical testing of hypotheses, correlation analysis, selection of the best model.*

Program learning outcomes.

know*: Determination of numerical characteristics of random variables: mathematical expectation,*

variance, standard deviation; main types of distribution of random variables: binomial, Poisson, uniform, exponential, geometric, normal, Pearson, Student, Fisher distributions, numerical characteristics of random variable distribution functions; multidimensional laws of distribution, correlations of random variables; basics of sampling method, point and integral estimates of distribution parameters; basics of correlation analysis, least squares method; criteria for testing statistical hypotheses: Pearson's test, t-test, Fisher's test; basic principles of experiment planning: construction of models based on the results of the experiment, checking the models for adequacy, choosing the best model.

***be able**: Find the probabilities of random variables by the classical definition; find the mathematical expectation, variance and standard deviation of continuous and discrete random variables; determine the correlation coefficient of random variables; find confidence intervals for mathematical expectation, variance and standard deviation for a given level of reliability; use computer tools to approximate the data of the physical experiment; to carry out statistical check of accuracy of various methods of measurement; to analyze the balances, check the adequacy of the selected model.*

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

Prerequisites: Based on the knowledge gained by students in the study of such disciplines for in-depth knowledge of the specialty: higher mathematics, geomechanics, mathematical modeling of geomechanical processes, organization of research and innovation

3. The content of the discipline

Section 1. Implementation and effectiveness of research

Terminology, basic concepts and definitions

Classification of sciences and scientific researches

Stages of research work. Scientific and technical information. The main sources of scientific information.

Types of scientific publications. Types of educational publications. Reference and information publications.

Formulation of the research topic. Formulation of the purpose and tasks of research.

Methodology of theoretical research. Methodology of experimental research.

Analysis of the results of theoretical and experimental research. Formulation of conclusions and proposals.

Implementation and effectiveness of research

Section 2. Theory of the experiment. Processing of experimental data

Random variables. Errors in measuring physical quantities

Identification and accounting for random errors.

Some information from probability theory. Statistical processing of experimental data.

Laws of distribution of random variables. . Normalized standard distribution of random variables and Laplace function. Examples of using the Laplace function to calculate measurement errors. The use of the Student's distribution in estimating measurement errors.

Section 3. Fundamentals of experiment planning in research

Statistical processing of experimental data for large samples.

The use of distribution functions in the study of physical phenomena.

Taking into account the errors of the functions of approximate arguments

Section 4. The use of numerical optimization methods in the process of processing experimental data

Verification of experimental results for reproducibility.

Linearization of experimental dependences. Least squares method.

Application of the least squares method in the processing of calibration dependencies.

Calculations of physicochemical values and determination of corresponding errors.

4. Training materials and resources

Basic literature:

1. Responsible Science, Volume I: Ensuring the Integrity of the Research Process

http://www.nap.edu/catalog/1864.html

2. FOUNDATIONS OF SCIENTIFIC RESEARCH/ N. M. Glazunov/National Aviation University, 2012, 168 p. https://arxiv.org/ftp/arxiv/papers/1212/1212.1651.pdf

3. The Fundamentals of Scientific Research: An Introductory Laboratory Manual . Marcy A. Kelly, Pryce L. Haddix2015, 208 p

https://books.google.com.ua/books?id=Lf5RCgAAQBAJ&printsec=frontcover&source=gbs_atb#v=onepage&q&f=false

Additional literature:

1. *SOCIAL SCIENCE RESEARCH:PRINCIPLES, METHODS, AND PRACTICES. Anol Bhattacherjee, University of South Florida Second Edition 2012 http://www.uilis.unsyiah.ac.id/oer/files/original/12ffa9b24c0e15fd64288cc2261ee0ca.pdf*
2. *Ch 1: Fundamentals of Scientific Inquiry & Processes https://study.com/academy/topic/fundamentals-of-scientific-inquiry-processes.html*
3. *THE PRINCIPLES OF SCIENTIFIC MANAGEMENT Frederick Winslow Taylor, M.E., Sc.D https://wpscms.pearsoncmg.com/wps/media/objects/3109/3184076/taylor.pdf*
4. *Bilukha MT Fundamentals of scientific research: textbook. / MT Bilukha. - K.: Вища шк., 1997. - 271 c.*
5. *Solovyov SM Fundamentals of scientific research: textbook. way. / SM Solovyov. - Kyiv: Center for Educational Literature, 2007. - 176 p.*
6. *Biryukov VV Fundamentals of industrial biotechnology: textbook. manual / VV Biryukov. - M.: КолосС, 2004. - 296 c.*
7. *Methods of teaching and research in higher education: textbook. way. / [Goncharenko SV, Oleynik PM, Fedorchenko VK secret.]; for order. S. V. Goncharenko, P. M. Oleynik. - K.: Вища шк., 2003. - 323 p.*
8. *Krassovsky GI Planning of the experiment / GI Krassovsky, GF Filarentov. - Minsk: Belarus Publishing House. University, 1982. —302 p.*

Educational content

5. Methods of mastering the discipline (educational component)

Names of lecture topics and a list of main issues
Section 1. Implementation and effectiveness of research
Modern approaches to planning and execution of scientific researches, processing of results of experiment and use of mathematical methods of planning and optimization of experiment are resulted. The requirements for registration of research results are stated.
Section 2. Theory of the experiment. Processing of experimental data
Random variables. Errors in measuring physical quantities. Identification and accounting for random errors. The beginnings of probability theory. Statistical processing of experimental data. Laws of distribution of random variables. Normalized standard distribution of random variables and Laplace function. The use of Student's distribution in estimating measurement errors.
Section 3. Basics of experiment planning

in research

Experiment planning - basic concepts and definitions. Parameters and factors of technological process optimization. Ways to solve optimization problems. Gradient methods for determining the extremum of a function. Statistical analysis of the significance of the coefficients of the regression equation. Determining the region of the optimum response function in a simulated experiment.

Section 4. Using numerical optimization methods in the process of processing experimental data

Solving linear programming problems in MS EXCEL environment. Application of the golden section method in determining the coefficient of the equation. Combining analytical and numerical methods in determining the coefficients of the equation

The name of the topic of practical classes and a list of key issues

Examples of using the Laplace function to calculate measurement errors.

Examples of using the Student's distribution to calculate measurement errors

Solving optimization problems in MS EXCEL

Calculation of regression equation coefficients

6. Independent work of a student / graduate student

The name of the topic for self-study

Laws of distribution of random variables. Distribution according to the normal law — Gauss's law — Laplace. Using the Laplace function to calculate measurement errors.

Find a reliable probability that a single measurement result will not exceed certain specified limits.

The use of the Student's distribution in estimating measurement errors. The calculation of Student's coefficients is provided in MS EXCEL.

Policy and control

7. Course policy (educational component)

The system of requirements for students:

- attending lectures and practical classes is a mandatory component of studying the material
- at the lecture the teacher uses his own presentation material; uses Google Class to teach current lecture material, additional resources, labs, and more; Teacher gives you access to a specific Google Class directory to download electronic lab reports and MCR responses
- modular tests are written in lectures without the use of aids (mobile phones, tablets, etc.); the result is sent in a file to the appropriate Google Class directory
- incentive points are awarded for: active participation in lectures ;, preparation of reviews of scientific papers; presentations on one of the topics of the VTS discipline, etc. Number of encouraged points by more than 10
- penalty points are set for: late delivery of laboratory work. The number of penalty points is not more than 10

8. Types of control and rating system for evaluation of learning outcomes (RSO)

1. The student's rating from the credit module is calculated from 100 points.

The starting rating (during the semester) consists of points that the student receives for:

– writing 2 MCR in lectures;
– performance of an individual task;
– incentive and penalty points.

2. Scoring criteria:

2.1. Modular tests:

- each modular work consists of 2 questions on 10 points everyone - 40 points;
- absence from class without good reason - penalty - 2 points.

2.2. Execution of an individual task:
- flawless work - 60 points;
- there are certain shortcomings in the preparation or execution of work - 40 points;
- untimely delivery of settlement and graphic work - penalty - 10 points.

3. The presence of a positive assessment of the CI is a condition of admission to the test.

4. Test test is estimated at 66 points. The control task of this work consists of three questions from the list provided in the appendix to the work program of KM.

Each question is evaluated in 22 points according to the following criteria:
- "Excellent", complete answer (not less than 90% of the required information) - 22-20 points;
- "Good", a fairly complete answer (at least 75% of the required information, or minor inaccuracies) - 19-17 points;
- "Satisfactory", incomplete answer (not less than 60% of the required information and some errors) - 16-13 points;
- "Unsatisfactory", the answer does not meet the conditions for "satisfactory" - 0 points.

5. The condition of the first certification is to receive at least 16 points. The condition for the second certification is to obtain at least 45 points and enroll in the RGR.

4. The sum of rating points received by the student during the semester is transferred to the final grade according to the table. If the sum of points is less than 60, the student performs a test. In this case, the sum of points for the performance of DCR and credit test is transferred to the final grade according to the table.

5. A student who received more than 60 points in the semester may take part in the test. In this case, the points obtained by him on the test are final.

Table of correspondence of rating points to grades on a university scale:

Scores	*Rating*
100-95	Perfectly
94-85	Very good
84-75	Fine
74-65	Satisfactorily
64-60	Enough
Less than 60	Unsatisfactorily
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

List of questions to be submitted for semester control

Random variables. Errors in measuring physical quantities.
Identification and accounting of random errors.
The beginnings of probability theory. Statistical processing of experimental data. Laws of distribution of random variables.
Normalized standard distribution of random variables and Laplace function.
The use of Student's distribution in estimating measurement errors.
Experiment planning - basic concepts and definitions. Parameters and factors of technological process optimization.
Ways to solve optimization problems.
Gradient methods for determining the extremum of a function.
Statistical analysis of the significance of the coefficients of the regression equation.
Determining the region of the optimum response function in a simulated experiment.
Solving linear programming problems in MS EXCEL environment. Application of the golden section method in determining the coefficient of the equation.

Combining analytical and numerical methods in determining the coefficients of the equation

Work program of the discipline (syllabus):

Folded Associate Professor of Geoengineering, Doctor of Technical Sciences, Zuevskaya NV

Approved department _____ (protocol № ___ from _____)

Agreed Methodical commission of the faculty[1] (Minutes № __ of _____)

[1] Methodical Council of the University - for general university disciplines.