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

Department of Machines and Apparatus for Chemical and Oil Refining

Research methodology

Work program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	**Third (graduate)**
Branch of knowledge	13 - Mechanical engineering
Specialty	133 - Industry engineering
Educational program	"Industrial Engineering"
Status of the educational component	Normative
The scope of discipline	120 hours / 4 ECTS credits
Year of preparation, semester	1 course, autumn semester
Form of study	Eye (day)
Timetable	1 lecture and 1 practical lesson every two weeks
Semester control / control measures	Examination
Language of instruction	Ukrainian
Information about the course leader / teachers	Ph.D., Associate Professor, Seminsky Alexander Olegovich,forstd@ukr.net , @mahnv_kpi
Course placement	http://ci.kpi.ua

Curriculum of the discipline

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

The normative part of the training of doctors of philosophy begins with the discipline "Methodology of Scientific Research". The material of this discipline is used as a basis for the study of professional educational components and the implementation of an individual training program for applicants.

The purpose of the discipline is to master the methods of research processes in the field of mechanical engineering, planning and organization of experimental research, determination of measurement errors, reliability and reproducibility of experiments.

The discipline forms the following competencies:

- ability to abstract thinking analysis and synthesis;
- ability to scientific knowledge, application of acquired knowledge in practice on the basis of general and special methodology;
- ability to use standard analytical methods and computer software for research;
- ability to conduct analytical and experimental research activities; organization, planning and forecasting of research results;
- ability to initiate, organize and conduct comprehensive theoretical and experimental research in the field of research and innovation, which lead to the acquisition of new knowledge.

The program learning outcomes after studying the discipline include:

- knowledge of the basic provisions of the theory of errors;
- knowledge of the principles and patterns of statistical analysis of multiple measurements with random errors of technological processes;
- knowledge of the principles of planning experimental research with maximum informativeness.

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

The discipline forms the basis for the study of other disciplines necessary for the acquisition of in-depth knowledge of the specialty and helps to ensure the scientific component of the training program for doctors of philosophy. The level of training required for the study of the discipline is determined by the results of entrance examinations.

3. The content of the discipline

Topic 1. Organization and conduct of measurements, evaluation of their results.

Topic 2. Correlation.

Topic 3. Experiment planning.

Topic 4. Optimization of process parameters in industrial engineering.

4. Training materials and resources

Basic literature:

1. Entinson IR Theory of errors: lectures / I.R. Entinson. - K .: [b.v.], 2010. - 74 c.
2. Mayboroda RE Regression / R.Ye. Mayboroda. - K .: TBiMC, 2004. - 283 c.
3. Methodology of scientific research [Electronic resource] / NTUU "KPI"; structure. A.L. Концевой, I.M. Astrelin, S.A. Terminal. - Electronic text data (1 file: 2.31 MB). - K .: NTUU "KPI", 2012. - Name from the screen.
4. Nazarenko LA Planning and processing of experimental results: lecture notes. - Kharkiv: KNAMG, 2008. - 163 p.
5. Fundamentals of scientific research [Electronic resource] / I.M. Astrelin, A.L. Концевой, C.A. Terminal; KPI them. Igor Sikorsky. - Electronic text data (1 file: 11.38 MB). - K .: KPI them. Igor Sikorsky, 2017. - 315 p. - Name from the screen.
6. Tomashevsky OV Computer technologies of statistical data processing / O.B. Tomaszewski, VP Risikov. - Zaporozhye: Zaporozhye National Technical University, 2015. - 175 p.

Additional literature:

1. Adler Yu.P. Introduction to experiment planning / Yu.P. Adler - M .: Metallurgy, 1968. - 158 p.
2. Bondar AG Planning of the experiment in the optimization of chemical technology processes / A.G. Bondar, G.A. Статюха, И.А. Потяженко. - K .: Вища школа, 1980. - 264 c.
3. Gaidyshev I. Analysis and data processing / I. Gaidyshev. - СПб .: Питер, 2001. - 750 c.
4. Granovsky VA Methods of processing experimental data in measurements / V.A. Грановский, T.H. Raw. - M .: Energoatomizdat, 1990. - 288 p.
5. Demidenko EZ Linear and nonlinear regressions / E.Z. Demidenko. - M .: Finance and Statistics, 1981. - 304 p.
6. Johnson N. Statistics and experiment planning in engineering and science. Methods of experiment planning / N. Johnson, F. Lyon. - M .: Мир, 1981. - 517 c.

7. Zedginidze IG Planning an experiment for the study of multicomponent systems / I.G. Zedginidze - M .: Nauka, 1976. - 390 p.

8. Radchenko SG Formalized and heuristic solutions in regression analysis: monograph / SG Radchenko. - K .: Корнійчук, 2015. - 235 c.

9. Taylor J. Introduction to error theory / J. Taylor. - M .: Мир, 1985. - 272 c.

10. Cheremnykh EV Theory of experiment planning and examples of its application: a textbook / E.V. Cheremnykh, TM Salo. - Lviv: Lviv Polytechnic National University Publishing House, 2005. - 148 p.

Educational content

5. Methods of mastering the discipline (educational component)

Calendar-thematic plan

Week	*Content of educational work*	*VTS (84 hours according to the curriculum)*
Topic 1. Organization and conduct of measurements, evaluation of their results.		
1, And a week	**Lecture 1.**Organization of measurements as a component of the methodology of the experiment. The best estimate of the parameter. Measurement accuracy. Direct and indirect measurements. Errors and their types.	Elaboration of the subject of the lesson. Work with recommended literature.
2, Week II	**Practical lesson 1.**Determining the accuracy of measurements during experimental studies. Calculation of errors.	Elaboration of the subject of the lesson. Carrying out calculations based on experimental data.
3, And a week	**Lecture 2**. Statistical analysis of random errors. Normal distribution. The law of distribution of errors. The rule of three sigma. Data rejection. Chauvin's criterion.	Elaboration of the subject of the lesson.
4, Week II	**Practical lesson 2.** Calculation of statistical values.	Elaboration of the subject of the lesson. Carrying out calculations based on experimental data.
5, And a week	**Lecture 3.**Evaluation of experimental research results. Student's distribution, Fisher's criteria, Cochren's, chi-square. Practical aspects of their application.	Elaboration of the subject of the lesson.
6, Week II	**Practical lesson 3.**Statistical testing of hypotheses. Defining confidence intervals. Checking the reproducibility of experiments ..	Elaboration of the subject of the lesson. Practice of calculations and analysis of results.
7, And a week	**Lecture 4.**Least squares method and its practical application.	Elaboration of the subject of the lesson.
8, Week II	**Practical lesson 4.**Obtaining analytical dependences using the least squares method. Determining the parameters of dependencies.	Elaboration of the subject of the lesson. Practice of calculations on real examples and analysis of their results.
Topic 2. Correlation.		

Week	*Content of educational work*	*VTS (84 hours according to the curriculum)*
9, And a week	**Lecture 5.**Pair correlation. Correlation with many variables. Nonlinear correlation. Multiple regression.	Elaboration of the subject of the lesson.
10, Week II	**Practical lesson 5.** Examples of application of correlation theory to solve practical problems of industrial engineering ..	Elaboration of the subject of the lesson. Practice of calculations on real examples and analysis of their results.
Topic 3. Experiment planning.		
11, And a week	**Lecture 6**Optimization parameter. Factors. Model selection. Complete factorial experiment.	Elaboration of the subject of the lesson.
12, Week II	**Practical lesson 6.**Construction of matrices of complete factorial experiment and determination of coefficients of equations.	Elaboration of the subject of the lesson. Practice of calculations on real examples and analysis of their results.
13, And a week	**Lecture 7.**Reducing the number of experiments. Fractional factor experiment and features of its planning.	Elaboration of the subject of the lesson.
14, Week II	**Practical lesson 7.**Construction of matrices of fractional factor experiment and determination of coefficients of the received equations. Checking the significance of the coefficients.	Elaboration of the subject of the lesson. Practice of calculations on real examples and analysis of their results.
Topic 4. Optimization of process parameters in industrial engineering.		
15, And a week	**Lecture 8.**Optimization. The method of steep ascent. Simplex method.	Elaboration of the subject of the lesson.
16, Week II	**Practical lesson 8.**Examples of using optimization methods.	Elaboration of the subject of the lesson. Practice of calculations on real examples and analysis of their results.
17, And a week	**Lecture 9.**Research of the area of optimal conditions. Composite and rotatable planning.	Elaboration of the subject of the lesson.
18, Week II	**Practical lesson 9.** Credit lesson. Presentation by graduate students of the possibilities of the studied methods within the topics of dissertation research.	Preparation for the test.

6. Independent work of a student / graduate student

Types of independent work are listed in the table in paragraph 5, according to the training weeks and scheduled classes.

Policy and control

7. Course policy (educational component)

System of requirements for graduate students:

- **rules for attending classes**- Attendance of classes of all kinds (lectures, practical classes) - is obligatory both at training in classrooms, and at a distance mode of training. In the latter case, classes are held in the mode of Zoom-conferences and graduate students "visit" them by connecting to the links provided by teachers;
- **rules of conduct in the classroom**- not to interfere with unnecessary activities, conversations (including telephone) to other graduate students to listen to lectures or work in practical classes. Follow safety rules in classrooms and distance learning at home;
- **rules for crediting practical classes and accruing points for their performance** - the teacher evaluates the work of the graduate student during the lesson, the quality and timeliness of the presentation of the results of the task;
- **rules for the protection of individual tasks** - presentations of the possibilities of the studied methods within the topics of dissertation research are held at the last of the practical classes with a mandatory discussion of the presented results;
- **rules for assigning incentive and penalty points**- incentive points are not provided; 3 penalty points are awarded for absence from class without good reason, in case of untimely performance of practical tasks or untimely presentation;
- **policy of deadlines and rearrangements**:
  1) delivery and evaluation of the results of all tasks takes place exclusively during classroom classes;
  2) re-examination is carried out according to the schedule established at the university level in the terms determined by the teacher and reported to postgraduate students at the announcement of rating points;
- **academic integrity policy** - Postgraduate students are obliged to comply with the provisions of the Code of Honor and the requirements of academic integrity during the educational process.

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

Current control: evaluation of work in practical classes (performance of tasks in each of the classes is evaluated up to 6 points, the maximum for all practical classes is 42 points), preparation and presentation of the project on the research topic is estimated at a maximum of 18 points.

Calendar control: conducted twice a semester for 7-8 and 14-15 weeks as monitoring of the current state of compliance with the requirements of Syllabus - the graduate student receives "satisfactory" during the first and second calendar control, if his current rating is not less than 0.5 of the maximum number of points , possible at the time of control.

Semester controlconducted in the form of an examination consisting of two parts: written and oral. The written part provides answers to two questions (one theoretical, the second - practical). The questions are formulated in the tickets. The theoretical question is estimated at a maximum of 10 points, the practical question is estimated at a maximum of 20 points. The second part consists of an oral interview on the subject of the course related to the questions in the ticket. The second part is estimated at a maximum of 10 points. The total maximum number of points that can be obtained by passing the exam is 40.

Conditions of admission to semester control:

- admission to the exam is possible only in the case of successful completion of all practical classes and a presentation on the research topic;
- graduate students who received during the semester total rating score <25 before the exam is not allowed.

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)

Reassignment is carried out according to the "soft" scheme (with preservation of the points typed during a semester). Thus for each rearrangement 6 penalty points are added.

Work program of the discipline (syllabus):

Folded Associate Professor of MAHNV, Ph.D., Associate Professor Seminsky Alexander Olegovich.

Approved at the meeting of the Department of Machines and Apparatus of Chemical and Oil Refining (Protocol № 26 of 19 June 2021)

Agreed metodic commission of the Faculty of Engineering and Chemistry (Protocol № 11 of June 25, 2021)