National Aerospace University
"Kharkiv Aviation Institute"

Department *Aircraft Engine Design (№ 203)*

APPROVED
Guarantor of the educational program

Liudmyla KAPITANOVA
(signature) (first and last name)

" *30* " *08* 2024

SYLLABUS OF A *REQUIRED* ACADEMIC DISCIPLINE

ENGINEERING EXPERIMENT DESIGN

(academic discipline)

Field of education *13 «Mechanical Engineering»*
(code and name of a field of education)

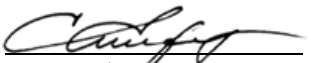
Field of study *134 « Aerospace Engineering »*
(code and name of field of study)

Educational program *Aircraft Designing, Manufacturing, Testing and Certification*
(name of Educational program)

Form of study: full-time

Academic degree: *Second (Magister)*
(academic degree)

Kharkiv 2024

Person, who developed the syllabus *Sergiy Yepifanov, DSc.,Professor* 

(author, position, academic degree and rank) (signature)

The syllabus of the academic discipline was approved at the meeting of the department

Aircraft Engine Design

(department)

Minutes № 1 dated « 30 » August 2024

Head of the department *DSc., Professor*  *S. Yepifanov*

(academic degree and rank) (signature) (first and last name)

1 Description of the discipline

<table>
<tr><td>Characteristics</td><td>Branch of science, specialization, academic degree</td><td>Description of the discipline
(full-time tuition)</td></tr>
<tr><td rowspan="2">Credits – 4</td><td>Field of education:
13 «Mechanical Engineering»</td><td rowspan="2">Required</td></tr>
<tr><td>(cipher and name)</td></tr>
<tr><td rowspan="2">Modules – 4</td><td rowspan="2">Field of study:
134 «Aerospace Engineering»</td><td>Academic year:</td></tr>
<tr><td>2024/2025</td></tr>
<tr><td>Semantic modules – 4</td><td rowspan="2">Semester</td></tr>
<tr><td rowspan="4">Individual task

Total number of academic hours – 64*/120</td><td rowspan="3">(cipher and name)

Educational program:
Aircraft Designing, Manufacturing, Testing and Certification
(name)</td></tr>
<tr><td>3-rd</td></tr>
<tr><td rowspan="8">Higher education:
second (magister)</td><td>Lectures *</td></tr>
<tr><td>32 a.h.</td></tr>
<tr><td>Practices, seminars *</td></tr>
<tr><td>32 a.h.</td></tr>
<tr><td>Number of academic hours for full-time tuition:

auditorium – 4

independent work – 3,5</td><td>Laboratory activities *</td></tr>
<tr><td>-</td></tr>
<tr><td>Independent work</td></tr>
<tr><td>56 a.h.</td></tr>
<tr><td>Form of examination</td></tr>
<tr><td>exam</td></tr>
</table>

The ratio of hours of classes to independent work is: for full-time education 64 / 56.

** Auditory load can be reduced or increased by one hour, depending on the schedule of classes.*

2. Goals and purposes of discipline

Goal: is forming of general and professional competences regarding to the State Education Standard of a high professional education on the specialty 134 *«Aerospace Engineering» and 272 «Aviation Transport».*

Task: This course provides a research work that evolves capacity to independent theoretical and practical work, judgment and solution, skills in objective estimation of scientific information, freedom of scientific discovering and trend to application of scientific knowledge in engineering activity.

According to the requirements of the educational-professional program, students must achieve such **competencies:**

General competencies: GC1 - the ability to identify the scientific essence and solve problems in the professional sphere, to find adequate ways to solve them; GC2 - the ability to abstract thinking, analysis and synthesis in the design of aircraft and helicopters; GC3 - the ability to identify, pose and solve problems; GC4 - the ability to conduct research to solve complex problems in professional activities; GK7 - the ability to investigate problems using systems analysis, synthesis, computer modeling and optimization methods; GC9 - the ability to analyze, verify, assess the completeness of information in the course of professional activity, if necessary, to supplement and synthesize missing information and work in conditions of uncertainty.

Special (professional) competencies: FC1 - Ability to formulate the purpose and objectives of the study, identify priorities for solving problems, select and create evaluation criteria; FC2 - Ability to apply modern research methods, evaluate and present the results of work; FC4 - Knowledge and ability to use the achievements of science and technology in professional activity; FC8 - Ability to apply mathematical theory of organization and planning of the experiment, to develop research plans, to choose algorithms for processing measurement information, as well as to use the necessary software to automate calculations; FC11 - Ability to apply basic knowledge in the field of mathematics for mathematical modeling of phenomena and objects in professional activities in the specialty.

Program learning outcomes: *Fluently communicate orally and in writing in state and foreign languages on professional matters. To have the means of modern information and communication technologies to the extent sufficient for studding and professional activities. To explain their decisions and the basis for their adoption to specialists and non-specialists in a clear and unambiguous form. To have the skills of self-study and autonomous work to refreshing professional skills and solve problems in a new or unfamiliar environment. To have the logic and methodology of scientific knowledge, based on an understanding of the current state and methodology of the subject area. To adhere to the requirements of industry regulations on procedures for the design, manufacture, testing and (or) certification of elements and objects of aerospace engineering at all stages of their life cycle. To explain the influence of design parameters of elements of aerospace engineering on its flight performance. Have an idea of the methods of ensuring the stability and controllability of aerospace engineering. To have the skills to form the models of the considered objects of aerospace engineering taking into account physical bases of the working process and functions of the object. To apply modern methods of testing of elements and systems of aerospace engineering in professional activities. To understand and justify the sequence of design, manufacturing, testing and (or) certification of elements and systems of aerospace engineering. To understand and justify design features and basic aspects of workflow in systems and elements of aerospace engineering. To have a basic knowledge on organization of testing of aircraft and its systems and units. To have the skills to design experiment for determining parameters of data-based and physic-base models.*

Partial tasks of the discipline are:

- knowledge forming about methodic bases of natural and digital experiments designing and their results processing for scientific grounded and reliable conclusions making;
- conception forming about a system of scientific knowledge and scientific research methods collection;
- knowledge forming about methods of designing and organization of theoretical and experimental researches;

- scientific researching methods studying, deep and creative acquisition of education material;
- ability for independent scientific research development;
- methods and tools studying of scientific and engineering tasks independent solution in research groups, methods of research work organization studying;
- ability development for scientific results skillful formatting and presentation;
- ability development for independent theoretical and practical thinking and concluding, skills in objective estimation of scientific information, freedom in scientific discovering and trend to application of scientific knowledge in engineering activity.

Learning outcomes:

After studying this discipline,

student must know:

– development of professional scientific-research thinking, clear conception about main professional tasks and methods of their solution;

– history of given scientific problem, its rile and place in a scientific direction to be studied;

– bases of mathematical statistics and designing theory;

– bases of random errors theory and methods of the random errors in experimental data estimation;

– basic principles and tasks of the dispersion and regression analysis;

– modern technologies of information accumulation, processing and presentation, skills in modern research methods;

– methods of statistical analysis, bases of statistical quality control, principles and methods of experiment designing, dynamic programming principle;

– tasks formulation and solution that are met in scientific and research activity and need in deep professional knowledge;

– searching for required scientific information using modern information technologies.

student must know how:

– understanding and unambiguously explain own conclusions about problems of aerospace engineering and also knowledge and explanations to the professionals and not the professionals;

– determine a required volume of experiment, design simple plans of experiments for the dispersion and regression analysis;

– make conclusions on results of the experimental data statistical analysis;

– practically make scientific researches, experimental works in scientific area;

– work with some software and Internet-sources;

– use modern technologies for information accumulation;

– independently make plans for task solution that appear in scientific and research activity and need in deep professional knowledge.

Prerequisites: Aerodynamics, Thermodynamics, Engineering Materials Science, Aviation Materials Science, Machine Parts and Construction Basics, Mechanics of Materials and Structures, Technology of Structural Materials, General Arrangement of Aviation Engines and Power Plants.

Requisites: Testing and Certification of Aerospace Engineering objects, Master's thesis.

3 Course content

Module 1
Semantic module 1

TOPIC 1. Goal and tasks of the discipline. Main terms and definitions. Goal of the research, subject and object of a scientific research. Objects of scientific research in aerospace engineering. Classification of scientific researches. Main types of scientific researches. Theoretical, theoretical-experimental and experimental researches. General scientific directions of the researches.

TOPIC 2. Methodology of scientific cognition. Facts, their generalization and systematization. Scientific research and its methodology. Basic levels of scientific cognition. Methods of empirical and theo-

retical researches. Phenomena studying using mathematical models. Scientific information and its sources.

TOPIC 3. Elements of mathematical statistics. Random variables and their characteristics. Random variables distribution laws. Sample and its characteristics. Confidence interval. Statistical hypotheses checking. Hypothesis about a law of distribution checking. Pearson and Kolmogorov criteria. Parametric hypotheses checking.

Module checking

Module 2
Semantic module 2

TOPIC 4. Method of theoretical and experimental research development. Theoretical research methods. Analytical research methods. Analytical research methods that use experimental data. Probabilistic-statistical research methods. Methods of system analysis. Models of researches.

TOPIC 5. Experimental researches. Metrological assurance of experiment. Physical variables and their measurement. Classification of physical variables. Basic terms of measurement theory. Methods of measurement. Errors of measurement. Mathematical model for results and errors of the measurement. Rules and forms of measurement results presentation.

TOPIC 6. Technique of experimental research. Classification of experiments. Methodology of experiment. Experiment design. Experiment making. Mathematical models for experimental data processing and analysis.

Module checking

Module 3
Semantic module 3

TOPIC 7. Design of experiment, stages of the design. Factorial experiment. Complete factorial experiment of 2^{κ} type. Design matrix forming. Methods of transfer from small-dimensional matrices to great-dimensional matrices. Properties of the complete factorial experiment of 2^{k} type. Optimality criteria and types of plans.

TOPIC 8. Complete factorial experiment and mathematical model. Estimation of response function coefficients. Fractional factorial experiment. Generated relations and key contrasts. Half-replicates. Choice of 1/4-replicates. Characteristics of fractional replicates. Response function coefficients estimation in a fractional factorial experiment. Composite designs. Orthogonal central composite designs.

TOPIC 9. Group method of data handling (GMDH), its purpose. Conditions of GMDH application. Method of a regression model acquisition. The model adequacy checking. Regression coefficients validity estimation.

TOPIC 10. Factorial analysis, its types and methods. Goals and tasks of the factorial analysis. Principal components method. Types of the factorial analysis. Stages of the factorial analysis. Classification of the factorial analysis methods. Interpretation of the factorial experiment results.

Module checking

Module 4
Semantic module 4

TOPIC 11. Special experiment designing methods. Expert estimation methods. Forms of expertise organization: brainstorm methods, discussion, commission, judgement, business meetings, decision matrix, prediction graph.

TOPIC 12. Scientific research results processing and presentation. Graphical processing of measurement results. Scientific research results presentation. Structure of scientific report.

Module checking

4 Course arrangement

Names of Modules and Topics	Number of hours full-time tuition				
	total	including			
		lec.	lab.	pr.	i.w.
1	2	3	4	5	6
Module 1 Semantic module 1					
TOPIC 1. Goal and tasks of the discipline. Main terms and definitions. Goal of the research, subject and object of a scientific research. Objects of scientific research in aerospace engineering. Classification of scientific researches. Main types of scientific researches. Theoretical, theoretical-experimental and experimental researches. General scientific directions of the researches.	6	2	-	2	2
TOPIC 2. Methodology of scientific cognition. Facts, their generalization and systematization. Scientific research and its methodology. Basic levels of scientific cognition. Methods of empirical and theoretical researches. Phenomena studying using mathematical models. Scientific information and its sources.	8	4	-	2	2
TOPIC 3. Elements of mathematical statistics. Random variables and their characteristics. Random variables distribution laws. Sample and its characteristics. Confidence interval. Statistical hypotheses checking. Hypothesis about a law of distribution checking. Pearson and Kolmogorov criteria. Parametric hypotheses checking.	15	3	-	6	6
Module checking	1	1			
Totally for module 1	**30**	**10**	**-**	**10**	**10**
Module 2 Semantic module 2					
TOPIC 4. Method of theoretical and experimental research development. Theoretical research methods. Analytical research methods. Analytical research methods that use experimental data. Probabilistic-statistical research methods. Methods of system analysis. Models of researches.	6	2	-	-	4
TOPIC 5. Experimental researches. Metrological assurance of experiment. Physical variables and their measurement. Classification of physical variables. Basic terms of measurement theory. Methods of measurement. Errors of measurement. Mathematical model for results and errors of the measurement. Rules and forms of measurement results presentation.	13	3	-	4	6
TOPIC 6. Technique of experimental research. Classification of experiments. Methodology of experiment. Experiment design. Experiment making. Mathematical models for experimental data processing and analysis.	6	2	-	-	4
Module checking	1	1			
Totally for module 2	**26**	**8**	**-**	**4**	**14**
Module 3 Semantic module 3					
TOPIC 7. Design of experiment, stages of the design. Factorial experiment. Complete factorial experiment of 2^{κ} type. Design matrix forming. Methods of transfer from small-dimensional matrices to great-dimensional matrices. Properties of the complete factorial experiment of 2^{k} type. Optimality criteria and types of plans.	13	3	-	4	6

TOPIC 8. Complete factorial experiment and mathematical model. Estimation of response function coefficients. Fractional factorial experiment. Generated relations and key contrasts. Half-replicates. Choice of 1/4-replicates. Characteristics of fractional replicates. Response function coefficients estimation in a fractional factorial experiment. Composite designs. Orthogonal central composite designs.	12	2	-	4	6
TOPIC 9. Group method of data handling (GMDH), its purpose. Conditions of GMDH application. Method of a regression model acquisition. The model adequacy checking. Regression coefficients validity estimation.	12	2	-	4	6
TOPIC 10. Factorial analysis, its types and methods. Goals and tasks of the factorial analysis. Principal components method. Types of the factorial analysis. Stages of the factorial analysis. Classification of the factorial analysis methods. Interpretation of the factorial experiment results.	12	2	-	4	6
Module checking	1	1			
Totally for module 3	**50**	**10**	**-**	**16**	**24**
Module 4 **Semantic module 4**					
TOPIC 11. Special experiment designing methods. Expert estimation methods. Forms of expertise organization: brainstorm methods, discussion, commission, judgement, business meetings, decision matrix, prediction graph.	6	2	-	-	4
TOPIC 12. Scientific research results processing and presentation. Graphical processing of measurement results. Scientific research results presentation. Structure of scientific report.	7	1	-	2	4
Module checking	1	1			
Totally for module 4	**14**	**4**	**-**	**2**	**8**
Totally for course	**120**	**32**	**-**	**32**	**56**

5 Practical works

№	Name	Hours
1	Technology of innovation design	4
2	Pressure sensor choice, estimation of different factors influences on its metrological characteristics	4
3	Hypothesis checking about a random variable distribution	4
4	Vibration gages calibration and amplitude-frequency characteristics determining	4
5	Experiment designing and its characteristics determining	4
6	Engine specific parameters determining using an experiment design	4
7	Complete design of experiment development for influence determining of constructive and maintenance factors on a temperature state of a bearing support	4
8	Regression model forming of a bearing support temperature state and a factorial analysis making. Scientific research results presentation	4
	Total	**32**

6. Independent work

№	Name	Hours
1	**TOPIC 1.** Goal and tasks of the discipline. Main terms and definitions. Goal of the research, subject and object of a scientific research. Objects of scientific research in aerospace engineering. Classification of scientific researches. Main types of scientific researches. Theoretical, theoretical-experimental and experimental researches.	2

	General scientific directions of the researches.	
2	**TOPIC 2.** Methodology of scientific cognition. Facts, their generalization and systematization. Scientific research and its methodology. Basic levels of scientific cognition. Methods of empirical and theoretical researches. Phenomena studying using mathematical models. Scientific information and its sources.	2
3	**TOPIC 3.** Elements of mathematical statistics. Random variables and their characteristics. Random variables distribution laws. Sample and its characteristics. Confidence interval. Statistical hypotheses checking. Hypothesis about a law of distribution checking. Pearson and Kolmogorov criteria. Parametric hypotheses checking.	6
4	**TOPIC 4.** Method of theoretical and experimental research development. Theoretical research methods. Analytical research methods. Analytical research methods that use experimental data. Probabilistic-statistical research methods. Methods of system analysis. Models of researches.	4
5	**TOPIC 5.** Experimental researches. Metrological assurance of experiment. Physical variables and their measurement. Classification of physical variables. Basic terms of measurement theory. Methods of measurement. Errors of measurement. Mathematical model for results and errors of the measurement. Rules and forms of measurement results presentation.	6
6	**TOPIC 6.** Technique of experimental research. Classification of experiments. Methodology of experiment. Experiment design. Experiment making. Mathematical models for experimental data processing and analysis.	4
7	**TOPIC 7.** Design of experiment, stages of the design. Factorial experiment. Complete factorial experiment of 2^{κ} type. Design matrix forming. Methods of transfer from small-dimensional matrices to great-dimensional matrices. Properties of the complete factorial experiment of 2^{k} type. Optimality criteria and types of plans.	6
8	**TOPIC 8.** Complete factorial experiment and mathematical model. Estimation of response function coefficients. Fractional factorial experiment. Generated relations and key contrasts. Half-replicates. Choice of 1/4-replicates. Characteristics of fractional replicates. Response function coefficients estimation in a fractional factorial experiment. Composite designs. Orthogonal central composite designs.	6
9	**TOPIC 9.** Group method of data handling (GMDH), its purpose. Conditions of GMDH application. Method of a regression model acquisition. The model adequacy checking. Regression coefficients validity estimation.	6
10	**TOPIC 10.** Factorial analysis, its types and methods. Goals and tasks of the factorial analysis. Principal components method. Types of the factorial analysis. Stages of the factorial analysis. Classification of the factorial analysis methods. Interpretation of the factorial experiment results.	6
11	**TOPIC 11.** Special experiment designing methods. Expert estimation methods. Forms of expertise organization: brainstorm methods, discussion, commission, judgement, business meetings, decision matrix, prediction graph.	4
12	**TOPIC 12.** Scientific research results processing and presentation. Graphical processing of measurement results. Scientific research results presentation. Structure of scientific report.	4
	Total	**56**

7 Learning methods

Basic forms of learning:

- lectures;
- independent work.

Lecture gives to student basic conceptions, bases of theory, relations which necessary to prepare for laboratory works and individual task.

Lecture solves one didactic problem only – gives primary knowledge about subject of topic, formulates main problems.

Practical works are based on verbal (analytic) description of the object and its presentation using didactic materials (educational software, laboratory facilities, mockups, posters etc.). During practical works, both individual and team-based approach of work is applied. Practical works are related with tasks of sensors choice, their metrological characteristics estimation, designing of experiments, engine parameters simulation, influence of design and maintenance factors on its performances determining.

Main form of learning is independent work. It cannot be done without preliminary knowledge given at lecture. During independent work, students study lecture material, prepare to practical works.

Questions for independent work

1. What is named as a distribution function and a density distribution function of a random variable?
2. Give definition of the mathematical expectation and the dispersion of a random variable.
3. Main laws of a random variable distribution that are used at the design of experiment. Numerical characteristics of these laws.
4. Give definition of the entire assembly and the sample.
5. Characteristics of precision and quality of a point estimate.
6. The interval estimates and the confidence interval.
7. What is named as a statistical hypothesis? Parametric and non-parametric hypotheses.
8. Why the basic hypothesis is named as the null hypothesis?
9. What is named as a level of significance and a hypothesis acceptation area?
10. Give definition of a statistical criterion. What is named is the power of test?
11. Name stages of a hypothesis checking.
12. What are I-type and II-type errors and how their probability is determined?
13. Tasks that are solved at the hypothesis about a law of distribution checking.
14. Role of Pearson and Kolmogorov criteria in the hypothesis about a law of distribution checking.
15. What statistical criteria are used at parametric hypotheses checking?
16. Basic hypotheses about sampled mean values, order of their checking.
17. Parasitic errors detection using parametric hypotheses.
18. Give a definition of a physical variable.
19. Name main types of physical variables. Give characteristics of each type.
20. Name methods of measurement. Give characteristics of each method.
21. What is named as a measurement error?
22 Errors classification on a form of a quantification.
23. Errors classification on a character of their behavior in time.
24. Errors classification on their origination.
25. Mathematical model of a measurement result.
26. Mathematical model of a measurement error.
27. Features of additive and multiplicative components of a measurement error.
28. How a measurement result must be presented correctly?
29. Formulate rules of measurement results rounding.
30. Give a definition of an experiment.
31. What tasks a designing of experiment solves?
32. Classification of experiments.
33. Give a definition of the mathematical model of a researched object.
34. What is named as a factor and the factor definition area?
35. What is named as a response function and a response surface?
36. Types of mathematical models.
37. Name stages of experimental researches.
38. Name main tasks of an experiment.
39. Requirements to the factors.
40. What is named as levels of a factor and the factor variability interval?

41. What limitations must be taken into account at the variability interval choice?
42. How the number of tests in experiment depends on the number of factors?
43. Give a definition of the factor space.

8 Testing

The course is divided into four modules:

1. Scientific cognition and its methodology. Role of experiment. Elements of mathematical statistics.

2. Methodology of experiment, role of mathematical models in experimental data processing and analysis.

3. Factorial experiment, regression and factorial analysis.

4. Scientific research results processing and presentation.

Module 1 is passed during *4-th* week (one attempt), module 2 is passed during *8-th* week (one attempt), module 3 – during *12-th* week (one attempt), module 4 – during *на 16-th* week (one attempt).

Before passing modulus, student must make all practical works and independent work of this modulus.

Execution of practical works – in writing form, defense – orally.

Semester 1 – **examination.**

9. Evaluation criteria and distribution of the points that the students get

9.1 Distribution of the points that the students get (quantitative evaluation criteria)

Components of educational work	Points for one lesson (task)	Number of lessons (tasks)	Total number of points
Module 1			
Work at lectures	0…1	5	0…5
Execution and defense of laboratory (practical) works	2…4	5	10…20
Modular testing	3…5	1	3…5
Module 2			
Work at lectures	0…1	4	0…4
Execution and defense of laboratory (practical) works	3…4	2	12…8
Modular testing	3…5	1	3…5
Module 3			
Work at lectures	0…1	5	0…5
Execution and defense of laboratory (practical) works	3…4	8	24…32
Modular testing	3…5	1	3…5
Module 4			
Work at lectures	0…1	2	0…2
Execution and defense of laboratory (practical) works	2…4	1	2…4
Modular testing	3…5	1	3…5
			60…100

Semester testing (examination) is held in case the student gives up points of modular testing and is permitted to the examination. The permission is given if the student has finished and passed all practical works.

Maximum total score of the examination is 100 points.

The examination card is composed of four theoretical questions and one practical task. The theoretical questions are distributed as follows:

The first question – theoretical part (module 1);

The second question – experiment methodology and data processing (module 2);
The third question – factorial experiment, regression and factorial analysis (module 3);
The fourth question – experimental results presentation (module 4)
Maximum number of points for each question is 25.

9.2 Qualitive evaluation criteria

To get positive mark, the student must

know:

– development of professional scientific and research thinking, main professional tasks and methods of their solution;

– history of the given scientific problem development, its role and place in the studied scientific area;

– basic terms of the mathematical statistics and theory of experiment;

– bases of the random error theory and methods of random errors estimation in measurements;

– basic principles and tasks of the dispersion and regression analysis;

– modern technologies of experimental information collection, processing and interpretation, modern methods of experimental research;

– methods of statistical analysis, bases of statistical quality control, principles and methods of experiment design, principle of dynamic programming;

– tasks formulation and solving that originate in scientific and research activity and need in deep professional knowledge;

– searching for a required scientific information using modern information technologies.

know how:

– understanding and non-ambiguously deliver own conclusions about problems of aerospace engineering, and also knowledge and explanations to the specialists and not specialists;

– determine a required volume of the experiment for a dispersion and regression analysis;

– make conclusions on results of statistical analysis of experimental data;

– practically make scientific researches in scientific area;

– work with some software and Internet-resources;

– use modern technologies of information collection;

– independently plan the tasks solution that originate at scientific and research activity and need in deep professional knowledge.

9.3 Criteria of the student evaluation during semester

Satisfactory (60-74). The student must have the required minimum of knowledge. He must finish and pass all practical works, pass modular testing with positive mark. He must know a distribution function and a density distribution function of a random variable; main laws of a random variable distribution that are used at design of; what is an entire assembly, interval estimate and confidence interval; what is named as a statistical hypothesis; what are I-type and II-type errors, tasks that are solved at the hypothesis checking about a law of distribution, Pearson and Kolmogorov criteria for the hypothesis checking about a law of distribution; basic hypotheses about sample mean, order of their checking; main types of physical variables; methods of measurement, their characteristics, measurement errors, classification of errors, rules of measurement results rounding; what tasks the design of experiment solves, classification of experiments; definition of the mathematical model of the researched object, response function and response surface, types of mathematical models; stages of experimental researches, main tasks of the experiment; requirements to factors, what limitations are to be taken into account at the variance interval choice, how the number of tests in the experiment depends on the number of the factors levels; what is the factor space.

Good (75-89). The student must be proficient in minimum knowledge. He must finish and pass all practical works with good mark, pass modular testing with positive mark. Know what is named as a distribution function and a density distribution function of a random variable, what is mathematical expectation and dispersion of a random variable; main laws of a random variable distribution that are used in a design of experiment; what is the entire assembly, interval estimate and confidence interval, what is named as a statistical hypothesis; what is named as the significance level and the hypothesis acceptable region, stages of a hypothesis checking; what are I-type and II-type errors, tasks that are solved at the hypothesis checking about a law of distribution, Pearson and Kolmogorov criteria for the hypothesis checking about a law of distribution; basic hypotheses about sample mean, order of their checking, parasitic errors detection using the parametric hypotheses; main types of physical variables; methods of measurement, their characteristics, measurement errors, classification of errors, mathematical model of measurement results and errors, rules of measurement results rounding; what tasks the design of experiment solves, classification of experiments; definition of the mathematical model of the researched object, response function and response surface, types of mathematical models; stages of experimental researches, main tasks of the experiment; requirements to factors, what limitations are to be taken into account at the variance interval choice, how the number of tests in the experiment depends on the number of the factors levels; what is the factor space.

Excellent (90-100). He must finish and pass all practical works with good or excellent mark, pass modular testing with excellent mark (one or two modules with “good” mark and minimum 80 points are permitted). Know what is named as a distribution function and a density distribution function of a random variable, what is mathematical expectation and dispersion of a random variable; main laws of a random variable distribution that are used in a design of experiment; what is the entire assembly, interval estimate and confidence interval, what is named as a statistical hypothesis; what are parametric and non-parametric hypotheses; what is named as the significance level and the hypothesis acceptable region, stages of a hypothesis checking; what are I-type and II-type errors, tasks that are solved at the hypothesis checking about a law of distribution, Pearson and Kolmogorov criteria for the hypothesis checking about a law of distribution; what statistical criteria are used for the parametric hypothesis checking; basic hypotheses about sample mean, order of their checking, parasitic errors detection using the parametric hypotheses; main types of physical variables; methods of measurement, their characteristics, measurement errors, classification of errors on a form of quantitative expression and behaviour in a time, mathematical model of measurement results and errors, rules of measurement results rounding; what tasks the design of experiment solves, classification of experiments; definition of the mathematical model of the researched object, response function and response surface, types of mathematical models; stages of experimental researches, main tasks of the experiment; requirements to factors, what limitations are to be taken into account at the variance interval choice, how the number of tests in the experiment depends on the number of the factors levels; what is the factor space.

Grade scales: national and ECTS

Grade scale	National scale	
	For exam, course project (work), practice	For test
90-100	“excellent”	Passed
75-89	“good”	
60-74	“satisfactory”	
0-59	“non-satisfactory”	Not passed t

10 Methodological support

1. Mathematical model of the aircraft engine.
2. Mathematical model of the gas turbine drive lubrication system.
3. Educational software for pressure sensors properties analysis.
3. Laboratory facility for vibration gages calibration and amplitude-frequency characteristics determining.

4. Software for GMDH application.
5. Software for the factor analysis application.
6. Methodical recommendations on the practical works making.

11 Recommended literature for the course

Main

1. Hinkelmann, Klaus. Design and analysis of experiments. Volume 2. Advanced Experimental Design / Klaus Hinkelmann, Oscar Kempthorne. John Wiley & Sons, Inc., 2005. – 780 pp.
2. Hinkelmann, Klaus. Design and analysis of experiments. Volume 3. Special designs and applications / Klaus Hinkelmann. John Wiley & Sons, Inc., 2012. – 555 pp.
3. Hinkelmann, Klaus. Design and analysis of experiments. Volume 1. Introduction to Experimental Design / Klaus Hinkelmann, Oscar Kempthorne. John Wiley & Sons, Inc., 2008. – 631 pp.
4. Montgomery, D. C. Design and analysis of experiments / Douglas C. Montgomery. Arizona State University. Ninth edition. | Hoboken, NJ : John Wiley & Sons, Inc., 2017. – 634 pp.
5. Selvamuthu, D., Das, D. Introduction to Statistical Methods, Design of Experiments and Statistical Quality Control / D. Selvamuthu, D. Das. Springer Nature Singapore Pte Ltd. 2018. – 430 pp.

Additional

6. Moffat, R. J. Planning and Executing Credible Experiments. A Guidebook for Engineering, Science, Industrial Processes, Agriculture, and Business / R. J. Moffat, R. W. Henk. John Wiley & Sons. 2021. – 317 pp.
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12 Information resources

https://mentor.khai.edu/course/view.php?id=2102