Silabus
selective component

Aerodynamics, dynamics of hydraulic and pneumatic systems

Title of discipline:	**Aerodynamics of the car**
Level of higher education:	**Second**
Course page in Moodle:	https://dl2022.khadi-kh.com/course/view.php?id=1783
Volume of the educational component	**4 credits (120 hours)**
Form of final control	**Credit**
Consultations:	**according to the schedule**
Name of the department:	**Details of machines and theory of mechanisms and machines**
Language of instruction:	**English**
Course leader:	**Avershin Andrii Hennadiiovych, PhD, assistant**
Contact phone:	*+380 (050) 647-26-96*
E-mail:	*avershin.a@khadi.kharkov.ua*

Summary of the educational component:
The purpose of teaching the educational component is to train specialists to independently solve professional problems arising in the design of cars and internal combustion engines, and to evaluate solutions to problems obtained by approximate calculation methods.
Subject: the discipline is a pedagogically adapted system of concepts about theories and mathematical methods of studying aerodynamics, hydrodynamics, dynamics and strength of vehicle elements exposed to physical and mechanical fields of various nature, in relation to the calculation of machine and equipment elements.
The main objectives of the discipline are:

– study of the aerodynamic properties of vehicles, strength of machine elements and modeling of the flow of liquids and gases.

– familiarization with modern packages for numerical solution of equations of engineering calculation of three-dimensional problems.

– formation of skills in organizing independent research work and presenting the results of scientific research related to the improvement of the aerodynamic properties of the vehicle.

Prerequisites for studying the educational component:
The study of the component "Application of Finite Element Methods in Engineering" is based on the knowledge gained during the mastering of the educational components of the bachelor's program: "General Physics", "Higher Mathematics", "Theoretical Mechanics", "Resistance of Materials", "Hydraulics and Hydraulic Pneumatic Drive". The acquired theoretical knowledge and practical skills in the use of finite element methods are necessary for the diploma design in the specialty.

Competencies acquired by the applicant:
***General competencies*:**

– The ability to be critical and self-critical in modeling processes and solving problems of engineering analysis of aerodynamic characteristics of vehicles.

– Critical comprehension of advanced scientific facts, concepts, theories, principles for industrial engineering and the ability to apply them to solve complex problems of industrial engineering and ensure sustainable development.

Learning outcomes:

– know how to build a finite element mesh;
– know the formulation of problems that can be solved by numerical modeling;
– know the methods of applying methods for numerical solution of problems of strength of elements of cars and engines;
– know the methods of applying methods of numerical solution of hydrodynamics problems to the calculation of hydraulic and pneumatic systems of machines;
– know the features of solving problems and their analysis.
– to be able to:
– be able to use numerical calculation methods to analyze the strength of simple elements of cars and engines;
– be able to use methods of numerical calculation of hydraulic and pneumatic systems of machines;
– be able to analyze the results obtained;
– be able to apply software packages that implement numerical calculation methods.

Thematic plan

No. of the topic	Name of the topic (LC, LC, PR, NW, NW)	Number of hours	
		face-to-face	correspondence
1	LC Modern methods modeling problems of mechanics and hydroaerodynamics in mechanical engineering	2	2
	PO Familiarity with software systems for calculations.	2	2
	SR Modern methods modeling problems of mechanics and hydroaeromechanics	11	11
2	LC Theoretical foundations of grid construction. Grid generators.	2	2
	PR Building grids.	2	2
	SR Theoretical foundations of grid construction	11	11
3	LC Solving static problems of the theory of elasticity.	2	2
	PO Construction of three-dimensional finite element models of machine elements. Calculation of an internal combustion engine piston.	2	2
	SR : Solving static problems of the theory of elasticity.	11	11
4	LC Problems of calculating thermoelastic deformations	2	2
	PR Calculation of heat exchangers.	2	2
	SR Problems of calculating thermoelastic deformations	11	11
5	LC Calculation of fluid flow in pipelines	2	2
	PR Calculation of fluid flow in pipelines	2	2
	SR Calculation of fluid flow in pipelines	11	11
6	LC Calculating the flow of a viscous compressible fluid.	2	2
	PR Calculating the flow of a viscous compressible fluid.	2	2
	SR Calculating the flow of a viscous compressible fluid.	11	11
7	LC Execute linked calculations.	2	2
	PR Perform a combined analysis of the temperature and wall strength of the mixer	2	2
	SR Execution of coupled settlements	11	11
8	LC Performing coupled calculations on the example of a mixer	2	2

	PR Calculation of heat transfer from gas to water through solid pipe walls.	2	2
	SR Performing coupled calculations on the example of a mixer.	11	11
Together	LC	16	16
	PR (LR, NW)	16	16
	SR	88	88

Evaluation system and requirements:

Current performance

1 The current performance of applicants for the performance of educational types of work in classrooms and for the performance of independent work is assessed using a four-point grading scale with the subsequent conversion to a 100-point scale. When assessing current performance, all types of work provided by the curriculum are taken into account.

1.1 Lectures classes are assessed by determining the quality of performing specific tasks.

1.2 Practical classes are assessed by the quality of the control or individual task, the performance and execution of practical work.

1.3 Laboratory classes are assessed by by the quality performance of reports on of laboratory work.

1.4 Seminars and workshops classes are evaluated by quality of performance individual assignment/essay.

2 Assessment of the current performance of higher education students is carried out at each practical lesson (laboratory or seminar) on a four-point scale ("5", "4", "F", "2") and is recorded in the academic record book.

– "excellent": the applicant has mastered the theoretical material perfectly, demonstrates in-depth knowledge of the relevant topic or discipline, and the main provisions;

– "good": the applicant has mastered the theoretical material well, knows the main aspects of the primary sources and recommended literature, and presents it in an argumentative manner; has practical skills, expresses his/her views on certain problems, but makes certain inaccuracies and errors in the logic of theoretical content or in the analysis of practical content;

– "satisfactory": the applicant has basically mastered the theoretical knowledge of the subject or discipline, is familiar with the primary sources and recommended literature, but gives unconvincing answers, confuses concepts, is uncertain about answering additional questions, and lacks stable knowledge; when answering practical questions, he/she shows inaccurate knowledge, is unable to evaluate facts and phenomena, and relate them to the future profession;

– "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, is almost not familiar with primary sources and recommended literature, lacks scientific thinking, and has not developed practical skills.

3 The final grade for the current activity is recognized as the arithmetic mean of the points for each class, for individual work, and current tests according to the formula:

$$K^{current} = \frac{K1+K2+\ldots+Kn}{n},$$

Where $K^{current}$ – is the final assessment of success based on the results of the current control;

$K1, K2, \ldots, Kn$ – assessment of the success of the n-th measure of current control;

n - number of current control measures;

The scores are converted into points according to the conversion scale (Table 1).

Table 1 - Conversion of the average score for current activities to a multi-point scale

4-point scale	100- point scale	4- point scale	100- point scale	4- point scale	100- point scale	4- point scale	100- point scale
5	100	4,45	89	3,90	78	3,35	67
4,95	99	4,4	88	3,85	77	3,3	66
4,9	98	4,35	87	3,80	76	3,25	65
4,85	97	4,3	86	3,75	75	3,2	64
4,8	96	4,25	85	3,7	74	3,15	63
4,75	95	4,20	84	3,65	73	3,1	62
4,7	94	4,15	83	3,60	72	3,05	61
4,65	93	4,10	82	3,55	71	3	60
4,6	92	4,05	81	3,5	70	from 1.78 to 2.99	from 35 to 59
						re-pass	
4,55	91	4,00	80	3,45	69	from 0 to 1.77	from 0 to 34
4,5	90	3,95	79	3,4	68	re-examination	

Final evaluation

1 A higher education student receives a credit at the last class in the discipline based on the results of the current assessment. The average grade for the current activity is converted into points on a 100-point scale, according to the conversion table (Table 1).

Higher education students who have a current average grade in the discipline below "3" (60 points) in the last class can improve their current grade by taking tests in the discipline. Assessment of applicants' knowledge through testing is carried out on a scale:

– "Excellent": at least 90% of correct answers;
– "Very good": 82% to 89% of correct answers;
– "Good": 74% to 81% of correct answers;
– "Satisfactory": 67% to 73% of correct answers;
– "Satisfactory enough": 60% to 66% of correct answers;
– "Unsatisfactory": less than 60% of correct answers.

2 A condition for receiving credit is:

– making up all missed classes;
– the average current grade in the discipline is not lower than "3" (60 points).

3 Applicants are awarded additional points for individual independent work and participation in scientific events.

3.1 Additional points are added to the sum of points gained by the higher education student for the current academic activity (for disciplines for which the final form of control is a test), or to the final grade in the discipline for which the final form of control is an examination.

3.2 The number of additional points awarded for different types of individual tasks depends on their scope and significance:

– prize-winning places in the discipline at the international/national competition of student research papers - 20 points;
– prize-winning places in the discipline at national competitions - 20 points;
– participation in the international/national competition of scientific student works – 15 points
– participation in international/national scientific conferences of students and young scientists - 12 points;
– participation in all-Ukrainian competitions in the discipline - 10 points

– participation in competitions and scientific conferences of KhNADU in the discipline 5 points;
– completion of individual research (educational and research) tasks of increased complexity - 5 points..

3.3 The number of additional points cannot exceed 20 points.

4 The learning outcome is evaluated (select the appropriate one):

– on a two-point scale (passed/not passed) according to Table 2;

– on a 100-point scale (for differentiated testing) according to Table 3. The total score, including additional points, cannot exceed 100 points

Table 2 - Scale for converting points to the national grading system

On a 100-point scale	**According to the national**
from 60 points to 100 points	enrolled
less than 60 points	unaccounted for

Table 3 - Scale for assessing students' knowledge based on the results of the final control in the discipline

Score in points	Assessment by national scale		ECTS grade for the course	
	examinati	offset	Assessmen	Criteria
90-100	**Excellent**	**Enrolled**	**A**	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills to work with the material have been formed, all the learning tasks provided for by the training program have been completed, the quality of their performance has been assessed with a score
80–89	**Good**	**Enrolled**	**B**	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills to work with the material have been basically formed, all the learning tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum
75-79			**C**	Theoretical content of the course is fully mastered, without gaps, some practical skills of working with the material mastered are insufficiently developed, all learning tasks provided for by the curriculum are completed, the quality of any of them is not assessed with the minimum number of points, some types of tasks are completed with errors

Score in points	Assessment by national scale		ECTS grade for the course	
	examinati	offset	Assessmen	Criteria
67-74	**Satisfactory**		**D**	Theoretical content of the course is fully mastered, without gaps, some practical skills of working with the material mastered are insufficiently developed, all learning tasks provided for by the curriculum are completed, the quality of any of them is not assessed with the minimum number of points, some types of tasks are completed with errors
60–66			**E**	The theoretical content of the course is partially mastered, some practical skills have not been formed, many of the learning tasks provided for in the curriculum have not been completed, or the quality of some of them is assessed with a score close to the minimum.
35–59	**Unsatisfactory**	**Not credited**	**FX**	The theoretical content of the course is partially mastered, the necessary practical skills have not been formed, most of the assignments provided for in the curriculum have not been completed, or the quality of their performance is assessed with a score close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the assignments (with the possibility of retaking)
0–34	**Unacceptable**		**F**	The theoretical content of the course has not been mastered, the necessary practical skills have not been formed, all completed assignments contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the assignments (with a mandatory repeated course)

Course policy:

- the course involves teamwork, the classroom environment is friendly, creative, and open to constructive criticism;
- mastering the discipline requires mandatory attendance at lectures and practical classes, as well as independent work;
- independent work involves the study of individual topics of the discipline, which are submitted in accordance with the program for independent study, or have been considered briefly;
- all tasks provided by the program must be completed on time;

- if a higher education student is absent from classes for a valid reason, he/she presents the completed tasks during independent preparation and consultation with the teacher;
- while studying the course, higher education students must adhere to the rules of academic integrity set forth in the following documents: "Rules of Academic Integrity of Participants in the Educational Process of KhNADU" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf), "Academic Integrity. Checking the Text of Academic, Scientific and Qualification Works for Plagiarism" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf), "Moral and Ethical Code of Participants in the Educational Process of KhNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).
- in case of detection of the fact of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided in the silent book;
- cheating during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

Recommended reading:

1. Роговий А.С. Використання методів числового вирішення задач інженерного аналізу: навчальний посібник / А.С. Роговий. – Харків: ХНАДУ, 2019. –112 с.
2. Роговий А.С. Методичні вказівки до виконання практичних робіт з дисципліни «Застосування методу кінцевих елементів в техніці». - Харків: ХНАДУ, 2016. – 25 с.
3. Романенко Л.Г. Методичні вказівки до практичних занять з спеціального курсу “Застосування методу скінчених елементів”. - Харків: ХНАДУ, 2011. – 25 с.
4. Wendt, J.F.: Computational fluid dynamics. Springer, Berlin Heidelberg (2010)
5. Hucho, W-H., Aerodynamics of Road Vehicles. 4th edition. ISBN 0-7680-0029-7, 1998.
6. Ferziger, J. H., & Peric, M. (2002). Computational Methods for Fluid Dynamics. New York: Springer
7. Katz J. Automotive Aerodynamics / Joseph Katz., 2016. – 608 с. – (Wiley). – (Automotive Series).

Додаткові джерела:

1. https://dl.khadi.kharkov.ua/course/view.php?id=1388
3. http://www.ansys.com/Products/Fluids
5.https://www.solidworks.com/sw/products/simulation/computational-fluid-dynamics.htm
6.http://www.mallett.com/support/ansys-tutorials/

Розробник (розробники)
силабусу навчальної дисципліни _____ Авершин А.Г.
підпис ПІБ
Завідувач кафедри _____ Воропай О. В.
підпис ПІБ