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

Department of Aircraft and Rocket Engineering

AIRCRAFT AERODYNAMICS-2
Work program of the discipline (Syllabus)

Details of the discipline

Level of higher education	*First (bachelor)*
Field of knowledge	*13 Mechanical engineering*
Specialty	*134 Aviation and aerospace technologies*
Educational program	*Aviation and aerospace technologies*
Status of the discipline	*Normative*
Form of study	*Full-time form of study*
Year of preparation, semester	*3 course, spring*
The scope of the discipline	*72 hours*
Semester control / control measures	*test/modular control work*
Class schedule	*http://rozklad.kpi.ua/ lectures and practical classes are evenly distributed during the semester*
Language of instruction	*Ukrainian /english*
Information about course leader / teachers	*Lecturer: Doctor of Technical Sciences, Kabanyachyi V.V., vkabanyachyi@ukr.net* *Practical: Povarov S.A., sergey_povar@ukr.net*
Розміщення курсу	*https://campus.kpi.ua*

Curriculum

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

This discipline is designed to provide students with basic knowledge in theory and practical experience in the field of aircraft aerodynamics at low and high speeds. Also, the subject of the discipline is the study of methods of determining the aerodynamic characteristics of simple and complex objects in relative motion, both in a liquid and in a gaseous medium, methods of aerodynamic calculation and determination of the aircraft aerodynamic characteristics.

1. The purpose and tasks of the discipline.

1.1. The purpose of the discipline is the formation of students' abilities to:

- theoretical knowledge of aircraft aerodynamics;
- practical experience in the field of low-speed aerodynamics,
- aerodynamic calculation and determination of aircraft flight characteristics.

1.2. The main tasks of the discipline.

After mastering the discipline, the following learning outcomes must be demonstrated:

knowledge of: basic methods of aircraft aerodynamic design;
aerodynamic characteristics of the aircraft and its parts.

ability: based on the analysis results of prototype aerodynamic characteristics, to choose the most optimal version of the aircraft aerodynamic layout;
to determine the aerodynamic and flight characteristics of the aircraft in different flight modes.

experience: computer modeling and determination of aircraft aerodynamic characteristics based on geometric characteristics;
independent work with educational, methodological and reference literature on the calculation of aircraft aerodynamic characteristics.

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

The study of the material requires students to have basic knowledge, which they will receive in the process of studying the disciplines: higher mathematics, physics, theoretical mechanics and fluid dynamics.

Successful study of the discipline prepares students to study the following academic disciplines: "Dynamics of flight", "Practical aerodynamics", "Design and construction of aircraft", "Design of aircraft elements in CAD, CAM, CAE systems", "Technology of production of aircraft and EDU", " Diploma design (bachelor's thesis)".

3. The content of the discipline

Names of sections and topics	Number of hours			
	In total	including		
		Lectures	Practical	SIW
Section 1. Aerodynamic characteristics of wing.				
Topic 1.1. Aerodynamic characteristics of wing at low speeds.	18	6	6	6
Topic 1.2. Aerodynamic characteristics of wing at high speeds.	18	6	6	6
Section 2. Aerodynamic and moment characteristics of aircraft				
Topic 2.1. Aerodynamic characteristics of aircraft.	16	4	6	6
calculation work	8			8
modular control work	8	2		6
test	4	–	–	4
Hours in general:	**72**	**18**	**18**	**36**

4. Educational materials and resources

Basic literature:

1.1. Аеродинаміка літальних апаратів / Харків: ХУПС ім. Івана Кожедуба, 2015

1.2. Аеродинаміка літальних апаратів / Г. Н. Котельніков [та ін.]; ред. Ю. М. Терещенко. — К. : Вища освіта, 2002. — 254 с.

1.3. Snorri Gudmundsson General Aviation Aircraft Design: Applied Methods and Procedures. 225 Wyman Street, Waltham, MA 02451, USA, 2014 . - 1029 p.

1.4. Лемко О.Л. Навчальний посібник «Аеродинамічні характеристики транспортних літаків та їх розрахунок». Електронне навчальне видання. Київ: НТУУ «КПІ», 2012. - 75 с.

1.5. Аерогідрогазодинаміка: підручник / В. Г. Лебедь, Ю. І. Миргород, Є. О. Українець. — Х. : ХУПС ім. Івана Кожедуба, 2011.— 415 с.

1.6. Batchelor G.K. An Introduction to Fluid Dynamics. Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, UK, 2000. - 631 p.

1.7. Houghton E.L. & Carpenter P.W. Aerodynamics for Engineering Students. - Linacre House, Journal Hill, Oxford OX2 8DP, 2003. - 614 p.

1.8. Anderson, J. Fundamentals of Aerodynamics. McGraw-Hill Series in Aeronautical and Aerospace Engineering. New York: McGraw-Hill Education, 2011. - 1131 p.

1.9. Bertin, John J., Cummings, Russell M. Aerodynamics for Engineers. 6th edition. Cambridge University Press , 2021. - 820 p.

Supporting literature:

2.1. Schlichting H. Boundary-Layer Theory. Springer-Verlag Berlin Heidelberg, 2017. - 814 p.

2.2. E. L. Houghton, P. W. Carpenter, Steven Collicott, Daniel Valentine. Aerodynamics for Engineering Students. 7th Edition. Butterworth-Heinemann, 2016. ISBN 9780081001943.

2.3. Kuethe, Arnold, and Chuen-Yen Chow. Foundation of Aerodynamics. 5th ed. New York, NY: John Wiley and Sons, 1997. ISBN 0471129194.

2.4. Frank M. W. Fluid Mechanics. The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020, 2011. – 1131 p.

2.5. Кабанячий В.В. Навчальний посібник «Аеродинаміка літака: Курсова робота». Електронне навчальне видання. Київ: НТУУ «КПІ», 2019. 85 с.

2.6. Moran, Jack. An Introduction to Theoretical and Computational Aerodynamics. 1st ed. New York, NY: John Wiley and Sons, 2003. ISBN 0486428796.

2.7. Путята В. Й., Сідляр М. М. Гідроаеромеханіка. – К: Видавництво КДУ, 1963. – 479 с.

Online resources:

1. http://iat.kpi.ua
2. http://kpi.ua
3. NACA Library, USA, www.nasa.gov

Educational content

5. Methods of mastering the discipline (educational component)

Lecture classes.

№	The topic lecture name and list of main questions
Section 1. Aerodynamic characteristics of wing	
Topic 1.1. Aerodynamic characteristics of wing at low speeds.	
1	**Lecture 1. Designing an aerodynamic profile** History and development. Aerodynamic profile geometry. Type of pressure distribution. Determination of aerodynamic forces and pitch moment by pressure distribution. Pressure coefficient and characteristics. Relationship between geometry and pressure coefficient. Aerodynamic profile design. Typical problems of designing an aerodynamic profile.

	Task for independent work: study of aerodynamic characteristic dependences on Re number, degree of flow turbulence and profile shape. Literature: [1.1], [1.2], [1.3]
2	**Lecture 2. Wing design** Wing construction. Wing geometry. Wing geometry diagram. Wing design parameters. Distribution of lifting force. On distribution of wing lift. geometry and lift distribution. Distribution of circulation along wing span. The most advantageous wing shape in plan. Aerodynamic model of a finite wing. Lift distribution and characteristics. More detailed wing design. Non-flat wings and winglets. Wing layout problems. Task for independent work: studying of profile atlases, gaining experience working with them. Literature: [1.1], [1.2], [1.3]
3	**Lecture 3. Aerodynamic coefficients.** Aerodynamic forces and moments. Aerodynamic coefficients and profile quality. Dependence of aerodynamic coefficients on profile angle of attack. Polaris of profile. Inductive speed. Slant flow in the wings. Wing inductive resistance. Task for independent work: Study of pressure distribution by profile. Literature: [1.1], [1.2], [1.3]
	Topic 1.2. Aerodynamic characteristics of wing at high speeds.
4	**Lecture 4. Wing profile in transonic flow.** Nature of compressibility. Speed of sound. Mach number. Classification of flight speeds. Propagation of small disturbances. Concept of critical Mach number. Shock waves. Task for independent work**:** Study of flow modes around moving objec**ts** Literature: [1.1], [1.2], [1.3]
5	**Lecture 5. Influence of compressibility on aerodynamic characteristics** Aerodynamic characteristics of the profile at high subsonic speeds. Influence of wing geometric parameters on their aerodynamic characteristics at subsonic speeds. Features of flow around wing. Task for independent work: Study of wing shape influence on distributed aerodynamic characteristics. Literature: [1.1], [1.2], [1.3]
6	**Lecture 6. Wing profile in supersonic flow.** Aerodynamic characteristics of thin profile in supersonic flow. supersonic wings Classification of wing edges in supersonic flow. Lift and moment characteristics of wings at numbers M > 1. Task for independent work: Study of wing drag in supersonic flow. Literature: [1.1], [1.2], [1.3]
	Section 2. Aerodynamic and moment characteristics of aircraft
	Topic 2.1. Aerodynamic characteristics of aircraft.
7	**Lecture 7. Aerodynamic characteristics of airplane with take-off and landing high-lift devices** Wing high-lift devices and its influence on aircraft aerodynamic characteristics. Influence of wing shape on efficiency of high-lift devices. Control of boundary layer as a means of increasing an efficiency of high-lift devices. Estimation of lift of aircraft with high-lift devices

	and when boundary layer is blown. Drag and aerodynamic quality of aircraft with deviated high-lift devices. Task for independent work: Study of wing high-lift devices, designed to prevent separation. Literature: [1.1], [1.2], [1.3]
8	**Lecture 8. Aerodynamic characteristics of bodies of rotation** Geometrical and aerodynamic characteristics of hulls. Lift and drag of hull. Drag created by case bottom. Influence of angle of attack on the aerodynamic characteristics of hull. Task for independent work: Study of influence of M number and shape of hull on its aerodynamic characteristics. Literature: [1.1], [1.2], [1.3]

Practical lessons.

The credit module "Aircraft Aerodynamics – 2" contains 9 practical lessons.

The main purpose of practical lessons is to discuss and analyze content of lecture material, determine degree of its assimilation by students and explain unclear places.

№	Name of lesson subject and the list of main questions	Number of classroom hours
1.	Geometric characteristics of wing and its profile.	2
2.	Aerodynamic characteristics of wing at subsonic speeds.	2
3.	Geometric characteristics of aircraft parts.	2
4.	Lift of aircraft.	2
5.	Drag of aircraft.	2
6.	Aerodynamic moments of aircraft.	2
7.	Modes of flow around aircraft parts.	2
8.	Aerodynamic characteristics of aircraft with wing high-lift devices.	2
9.	Separation modes of flow around wing.	2

Independent work of students

The student's independent work consists in preparing for classroom classes, familiarization with thematic literature, performing calculation work.

Calculation and graphic work is issued at the semeste beginning individually to each student and is defended in form of a written work containing calculations and necessary graphic material (drawings, graphs, etc.) individually according to separate schedule.

Policy and control

7. Policy of academic discipline (educational component)

Grading policy (missed classes, making up for absences): each grade is assigned in accordance with the criteria developed by teacher and announced to students in advance, as well as motivated individually at the student request; if student does not complete all prescribed classes, he will not be admitted to credit; missed classes must be made up. The form and time of practice are mutually agreed upon by student and teacher.

Academic integrity

The policy and principles of academic integrity are defined in Chapter 3 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code

Norms of ethical behavior

Standards of ethical behavior of students and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute". More details: https://kpi.ua/code

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

In the first lesson, students get acquainted with the rating system of the discipline, which is built on the basis of the Regulation on the system of evaluation of learning results https://document.kpi.ua/files/2020_1-273.pdf

Current control is carried out at each practical lesson in accordance with the specific goals of the topic in order to check the degree and quality of material learning. In all classes, objective control of theoretical training and learning of practical skills is used to check the readiness of student for the class. In the process of current control, the student's independent work is evaluated in terms of the completeness of tasks, level of assimilation of educational materials, mastering of practical skills of analytical and research work, etc. The results of current control are entered into the Ihor Sikorsky KPI Campus System.

Calendar control: is carried out twice a semester as a monitoring of current state of fulfillment of the syllabus requirements. In order to receive "credited" from the first intermediate certification (8th week), student will have at least 9 points (provided that at the beginning of the 8th week, according to the calendar of control activities, the "ideal" student must receive 15 points). To receive "credited" from the second intermediate certification (14th week), the student will have at least 21 points (provided that at the beginning of the 14th week, according to the calendar plan of control activities, the "ideal" student should receive 30 points).

Student who scored less than 38 points in the academic discipline during the semester is not admitted to the exam.

The student's rating in the discipline consists of the points he receives for the following:

- practical work;
- calculation and graphic work;
- modular control work.

1. Practical work

Weight score – 5.

The maximum number of points is equal to 5 points x9 = 45 points.

Evaluation criteria:

- full completion of the task - 5;
- implementation, but theoretical knowledge is insufficient - 3...4;
- not prepared - 0.

2. Calculation and graphic work

Weight score – 8.

The maximum number of points is equal to 8 points x1 = 8 points.

Evaluation criteria:

- complete completion of the task - 8;
- implementation, but theoretical knowledge is insufficient — 5 ... 6;
- execution, but no report - 3;

• work was not performed - 0.

3. Modular control work

Weight score – 47.

The maximum number of points is equal to 47 points x 1 = 47 points.

Evaluation criteria:

• complete completion of the task - 47;

• incomplete completion of the task - 25...40;

• work was not performed - 0.

Penalty and incentive points:

• creative approach to work, active participation in discussion of topics, independent search for topics: +1...3 points;

• absence of missing lectures without valid reasons: +1...3 points;

• absence from class without a valid reason: –1...–5 points.

The maximum number of incentive points is 5.

Calculation of the rating scale (R):

Thus, the rating scale for the discipline is:

R = 45 + 8 + 47 = 100 points.

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

Scores	Rating
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Enough
Less than 60	Unsatisfactory
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

If a graduate student is transferred from another university is recalculated only if the curriculum is consistent.

Work program of the discipline (syllabus):

Compiled by Professor of the Department of Aircraft and Rocket Engineering, Doctor of Technical Sciences, Kabanyachyi V.V.

Approved by the Department of Aircraft and Rocket Engineering (Minutes № 13 of 09.06.2022)

Approved by the Methodological Commission of the IAT (Minutes № 4 of 30.06.2022)