STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Exploitation aircraft and aerial engines	**1010601161010633993**

Field of study	Profile of study (general academic, practical)	Year /Semester
Aerospace Engineering	**general academic**	**3 / 6**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Aircraft Engines and Airframes	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies	**full-time**

No. of hours	No. of credits
Lecture: **1** Classes: **1** Laboratory: **-** Project/seminars: **-**	**3**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
other	**university-wide**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**3 100%**
Technical sciences	**3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basic mathematical knowledge in the field of statistics and probability in calculating inertial navigation platforms data for BSP, reliability parameters and measures and indicators of the airframe and aircraft engine engineering of unmanned aircraft.
2	**Skills**	Student is able to adopt and plan the appropriate UAS operational process model and create computer support tools for the operation of airframe and unmanned aircraft engine using a spreadsheet or relational database.
3	**Social competencies**	He knows the limits of his knowledge and skills; can precisely formulate questions, understands the need for further education

Assumptions and objectives of the course:

Student will possess knowledge in the field of usage of unmanned aircraft, as well as the safety awareness and the existence of threats in the operation of unmanned aircraft.

- Teach the principles of maintaining BSP airframes and aircraft engines based on accepted service processes and operating models.
- Familiarize students with the basic issues related to reliability, readiness, operational vulnerability, durability, lifetime and operational properties of airframe and aircraft engines used in UAS;
- Teach students the basic construction planning methods of UAS design.
- Familiarize students with the principles of calculating the power of BSP propulsion units and the selection of power cells.
- Familiarization with currently used systems supporting navigation and data exchange between UAV systems.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Has knowledge in the field of mathematics, including algebra, analysis, theory of differential equations, probability, analytical geometry - [[K1_W01]]
2. Has a structured basic knowledge in the main branches of technical mechanics: statics of kinematics and dynamics of the material point and rigid body - [[K1_W04]]
3. Has basic knowledge in the field of machine construction and theory of machines and mechanisms - [[K1_W05]]
4. Has basic knowledge of standardized principles of construction record and engineering graphics - [[K1_W07]]

Skills:

1. Is able to use verbal communication in one additional foreign language at the level of everyday language - [[K1A_U07]]
2. Is able to prepare technical documentation descriptively - drawing an engineering task - [[K1A_U06]]
3. Can use the acquired mathematical theories to create and analyze simple mathematical models of machines and their components and simple technical systems - [[K1A_U09]]
4. Able to draw a diagram, a simple machine element and a component of the airframe according to the principles of technical drawing - [[K1A_U16]]

Social competencies:

1. Can think and act in a creative and enterprising way - [[K1A_K06]]
2. Is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on the environment and the related responsibility for decisions - [[K1A_K02]]
3. Understands the need and knows the possibilities of continuous learning - [[K1A_K01]]

Assessment methods of study outcomes

Written test

Course description

- History of unmanned aerial vehicles. Unmanned aircraft system - terminology and classifications Components of UAS. Basics of unmanned aircraft construction. Unmanned aerial vehicles in Poland ? procedures and law background. The BSP design and construction algorithms. Communication with unmanned platform, manipulators and control systems. Servomechanisms used in UAS (Unmened Aircraft Systems). Power supply of unmanned air systems and basic PWM controllers operation. Inertial Meassurement Unit IMU (Inertial Meassurement Unit) and Micro Electro Mechanical Systems (MEMS). Kalman filter - prediction of position, navigation and timing in space. Data exchange between UAV modules - data buses. PID controllers (Proportional, Integral, Derivative). Engines - principles for the selection of the UAS drive, the basis for calculating the power of drive units used to power UAS. Rules for the selection of propellers - balancing and construction. Power sources, types of load calculations and current efficiency in relation to the UAV structure. The construction of UAV airframe elements, wing, fuselage frame in the case of quadrocopters, cargo space ele- ments, chassis.

Basic bibliography:

1. Jerzy Lewitowicz, Kamila Kustroń: Podstawy eksploatacji statków powietrznych, Tom 1 i 2
2. Zbigniew Zagdański, Stany awaryjne statków powietrznych
3. Jerzy Lewitowicz, Leszek Lorycha, Jerzy Manerowski, Problemy badań i eksploatacji techniki lotniczej, Tom 6 Wydawnictwo Instytutu Technicznego Wojsk Lotniczych , Listopad 2006
4. Szczepanik R., Tomaszek H., Zarys metody oceny niezawodności i trwałości urządzeń lotniczych z uwzględnieniem stanów granicznych, Problemy Eksploatacji 2005
5. Tomaszek H., Żurek J., Jasztal M., Prognozowanie uszkodzeń zagrażających bezpieczeństwu lotów statków powietrznych, Wydawnictwo Naukowe Instytutu Technologii Eksploatacji, Warszawa 2008
6. Reg Austin: Unmanned Aircraft Systems
7. Ed.Rogelio Lozano: Unmanned Aerial Vehicles, Wiley 2010
8. Gierecki W., Drony i bezzałogowe statki powietrzne (UAV) Wydawnictwo Politechniki Poznańskiej, Poznań 2018
9. M. J. Dougherty, przekład J. Majszczyk, Drony : ilustrowany przewodnik po bezzałogowych pojazdach powietrznych i podwodnych, Warszawa Bellona, 2016
10. J. Karpowicz, K. Kozłowski Bezzałogowe statki powietrzne i miniaturowe aparaty latające : możliwości i zakres użycia w działaniach zbrojnych, Akademia Obrony Narodowej, Wydział Lotnictwa i Obrony Powietrznej. Katedra Lotnictwa, Akademia Obrony Narodowej-Wydział Wydawniczy, 2003
11. P. Majdan, B. Szulc, Kierunki rozwoju bezzałogowych statków powietrznych w aspekcie zmian zachodzących na współczesnym polu walki : kierunki rozwoju bezzałogowych statków powietrznych w aspekcie zmian zachodzących na współczesnym polu walki : sprawozdanie z realizacji tematu badawczego, Wydział Zarządzania i Dowodzenia, Akademia Obrony Narodowej, 2016
12. W. Melnarowicz, K. Melnarowicz, Bezzałogowe statki powietrzne : zastosowanie, przepisy normujące użytkowanie, system szkolenia, Wydawnictwo Instytutu Technicznego Wojsk Lotniczych, 2017
13. Joint Publication 1-02, Department of Defense Dictionary of Military and Associated Terms 200
14. Rozporządzenie Ministra Infrastruktury z dnia 15 lipca 2003 r. w sprawie klasyfikacji statków powietrznych.

Additional bibliography:

1. Paweł Lindstendt, Praktyczna diagnostyka maszyn i jej teoretyczne podstawy
2. Dzierżanowski p., (i inni), Napędy lotnicze, Turbinowe silniki śmigłowe i śmigłowcowe, Wydawnictwo Komunikacji i Łączności, 1985
3. Dzierżanowski p., (i inni), Napędy lotnicze, Turbinowe silniki odrzutowe, Wydawnictwo Komunikacji i Łączności, 1983
4. Dzierżanowski p., (i inni), Napędy lotnicze, Zespoły wirnikowe silników turbinowych, Wydawnictwo Komunikacji i Łączności, 1982
5. Józef Zieleziński, Budowa płatowców, Wydawnictwo Komunikacji i Łączności, Warszawa 1974
6. Kocańda S., Szala J.,Podstawy obliczeń zmęczeniowych, Wydawnictwo Naukowe PWN, 1997
7. D. B. Hume, Integration of weaponized unmanned aircraft into the air-to-ground system, Air War College, Air University, Maxwell Air Force Base, Alabama , AU Press, 2007
8. M. E. Griswold, Spectrum management : key to the future of unmanned aircraft systems, Air University, Air War College, Maxwell Air Force Base, Alabama, AU Press, 2008
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Result of average student's workload

Activity	Time (working hours)
1. Preparation for the exam	5
2. Participation in the exam	2
3. Participation in lectures	15

Student's workload

Source of workload	hours	ECTS
Total workload	15	3
Contact hours	15	3
Practical activities	0	0